THE PLANT DISEASE REPORTER

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The Plant Disease Reporter is issued as a service to plant pathologists throughout the United States. It contains reports, summaries, observations, and comments submitted voluntarily by qualified observers. These reports often are in the form of suggestions, queries, and opinions, frequently purely tentative, offered for consideration or discussion rather than as matters of established fact. In accepting and publishing this material the Plant Disease Epidemics and Identification Section serves merely as an informational clearing house. It does not assume responsibility for the subject matter.

THE PLANT DISEASE REPORTER

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PLANT DISEASE EPIDEMICS AND IDENTIFICATION SECTION

Crops Research Division — Plant Industry Station, Beltsville, Maryland
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IN THIS ISSUE

Circumstances accompanying unusual prevalence of stripe rust on wheat, from south to north in the Great Plains region including even some States where it had not been noticed previously, are described in reports by MAURICE C. FUTRELL, from Texas; H. C. YOUNG, Jr. and L. E. BROWDER, Oklahoma; S. M. PADY et al., Kansas; J. M. DALY, Nebraska; J. G. HENNEN, South Dakota; E. A. LUNGREN, Colorado; and J. R. VAUGHN, Wyoming; page 955.

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WHEAT STRIPE RUST EPIPHYTOTIC IN TEXAS IN 1957

Maurice C. Futrell[1]

An epiphytotic of stripe rust, Puccinia glumarum Eriks. & Henn.[2], developed in part of Texas in 1957 and spread north and west (see following reports). This was the first time P. glumarum has been recorded as becoming epiphytotic in the Great Plains region of the United States. It is the commonly accepted opinion that stripe rust usually does not develop in this region because of unfavorable climatic conditions. The disease had previously been recorded in trace amounts in the Texas counties of Brazos in 1941[3], Denton in 1953 (1), and Waller in 1956 (2). The heaviest of these infections was in 1956 on Concho wheat at Prairie View. Other infections have probably occurred in the State in past years but were not observed or recorded.

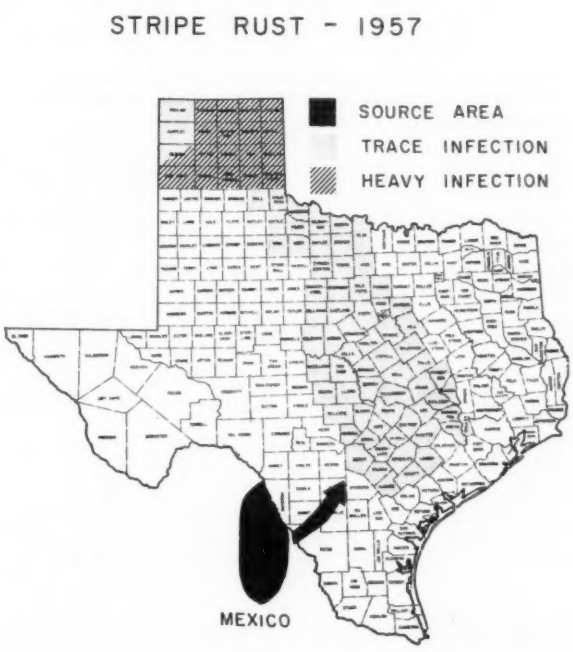

FIGURE 1. Source area and stripe rust development in Texas in 1957.

Traces of stripe rust developed in wheat fields over south and central Texas in the spring of 1957, becoming epiphytotic in the Texas Panhandle during June. During February and March stripe rust pustules were observed in experimental plantings or commercial fields in Bexar, Karnes, Waller, and Brazos Counties (Figure 1). The weather remained unseasonably cool during late winter and early spring and the disease continued to spread northward in trace amounts, with infection centers increasing in size in the southern part of the State. Infections were observed in Kendall, Travis, Williamson, and Bell Counties (Figure 1) on April 7. One field of durum wheat south of Temple showed 1 percent infection on 5 percent of the plants. The disease was observed in Wichita, Wilbarger, and Hardeman Counties

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[1]Plant Pathologist, United States Department of Agriculture, Agricultural Research Service, Crops Research Division, and Texas Agricultural Experiment Station.

[2][ED. NOTE: Under the provisions of the International Code of Botanical Nomenclature the correct name for this rust is P. striiformis West., but many workers will prefer P. glumarum Eriks. &. E. Henn. on the basis of usage.]

[3]McFadden, E. S. Unpublished Data, College Station, Texas.

Table 1. The response of some common hard red winter wheats to stripe rust at Bushland, Texas in 1957.[a]

Variety or selection	C. I. or selection number	Prevalence	Severity and response
Early Blackhull	8856	100	20 MR
Wichita	11952	100	50 S
Apache X Pawnee	Ks. sel. 5059	100	50 S
Crockett	12702	100	20 MR
Early Blackhull X Oro-Med.-Hope	13176	100	40 S
Marquillo-Oro X Wichita	----	100[b]	tr R
Comanche	11673	100	25 S
Westar	12110	100	80 S
Bison	12518	100	25 S
Kharkof	1442	100	5 R
Cheyenne	8881	100	1 R
Harveyland	----	50	tr R
Tenmarq	6936	100	50 S
Concho	12517	100	25 S
Red Chief	12109	100	5 R
Kan.-Hd. Fd.-Ten. X Hope-Med.	Texas 255-48-9	100	1 R
Cimarron X (Hope Cheyenne)	Texas 256-50-3	100	5 R
Cimarron X (Hope Cheyenne)	13022	100	8 R
(Kan.-Hd. Fed.-Ten.) X (Med.-Hope) X Cimarron	13023	100	8 R
(Kan.-Hd. Fed.-Ten.) X (Med.-Hope) X Cimarron	Texas 274-51-A4	100	50 S
(Kan.-Hd. Fed.-Ten.) X (Med.-Hope) X Cimarron	Texas 274-52-A182	100	1 R
(Cimarron X Hope-Cheyenne) X Comanche	13024	100	5 R
(Cimarron X Hope-Cheyenne) X Comanche	275-51-A46	100	5 R
Westar	12110	100	70 S

[a]Data taken by D. M. Stewart and M. C. Futrell

[b]Segregating with 10 percent of plants showing 20 S.

early in May. By the middle of May infection had occurred in northern counties of the Texas Panhandle. Here the disease increased rapidly and was epiphytotic by June 1 (Figure 1), and commercial fields were defoliated by mid-June due to heavy infections. Stripe rust was light in the extreme northwestern corner of the State (Figure 1).

To determine possible source areas for the primary inoculum of all rusts a study was made in northern Mexico during the first week of April. Stripe rust was found in commercial fields in the State of Coahuila along the highway from Eagle Pass, Texas to Saltillo, Coahuila. The amount of infection varied from traces in some to epiphytotic in others. The heaviest infection was found in commercial fields near Nava, Coahuila, where 100 percent of plants showed 50 percent severity. Wheats in the Saltillo area were later in maturity than average, and stripe rust was present in most fields. This area in Mexico probably served as the source area for the initial infection in Texas. However, the inoculum that initiated the epiphytotic in the Texas Panhandle could have been generated from the many trace infections in the State.

The combination of inoculum from light infections over a large area of Texas plus inoculum from the highland area of central Mexico, together with unusual environmental conditions, perhaps accounted for the development of the first stripe rust epiphytotic ever recorded in the wheat producing belt of the central United States.

Stripe rust thrives with abundant rainfall, cool temperatures, and high humidity. These conditions prevailed to some degree in south and central Texas during early spring, and the unusually heavy rains and cool weather which occurred in the Texas Panhandle during May and June made conditions ideal for stripe rust development.

The response of a number of the hard red winter wheat varieties and selections was recorded in nursery plots grown at Bushland, Texas[4] by Dr. D. M. Stewart and the author. These data are shown in Table 1. The varieties Wichita, Westar, Tenmarq, and the Texas selection 275-51-A4 were susceptible. Kharkof, Cheyenne, Harveyland, Red Chief, and Texas Selections 255-48-9, 256-50-3, 247-52-A182, 275-51-A46, C. I. 13022, C. I. 13023, and C. I. 13024 all showed resistance. All of these varieties were derived from Turkey wheat either by direct selection or hybridization.

Literature Cited

1. FUTRELL, M. C., and I. M. ATKINS. 1954. Diseases of small grains in Texas in 1953. Plant Dis. Reptr. 38: 167-168.
2. FUTRELL, M. C., and I. M. ATKINS. 1957. Trends in diseases of cereal crops in Texas in recent years. Plant Dis. Reptr. 41: 42-46.

CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND THE TEXAS AGRICULTURAL EXPERIMENT STATION, COLLEGE STATION, TEXAS

[4]Plots grown under supervision of Dr. K. B. Porter, Agronomist, Texas Agricultural Experiment Station.

OCCURRENCE OF STRIPE RUST IN OKLAHOMA IN 1957

H. C. Young, Jr., and L. E. Browder

A brief review of the records available indicates that stripe rust of wheat (Puccinia glumarum) [P. striiformis] has not been reported previously in Oklahoma. In the 1957 season this rust was observed generally over the State, though not in damaging quantity.

Stripe rust was first observed in the Stillwater area about June 1, and examination revealed that those pustules were first generation infections approximately 2 weeks old. Infections were first observed on hybrid lines involving Triticum sp. - Agropyron elongatum x Pawnee (C. I. 13020 and related lines) which carry some resistance to Septoria tritici. Most of the leaves of other wheat varieties had been destroyed by Septoria leaf blotch by that date. Further search revealed that any varieties or hybrids which still had green leaf surface carried a few pustules of stripe rust. As an average in the north-central area of the State, stripe rust was found on 90 to 95 percent of the plants with green leaves, with only a trace severity. Later, this rust was found to be generally present in the central, western, and Panhandle areas of Oklahoma, but seldom over 1 percent in severity. Distribution through the eastern and southern areas was limited by the severity of Septoria leaf blotch.

The appearance of this disease in Oklahoma was undoubtedly a function of the abnormal weather over the entire Southern Plains area during the spring months. Table 1 includes average measurements of certain weather factors for the Stillwater area. It can be observed

Table 1. Temperature and rainfall records for 4 months in 1957 at Stillwater, Oklahoma, compared with the same months in the 5 preceding years.

	1957	1956	1955	1954	1953	1952	40+ yr. Ave.
March							
Average temperature	49.1	53.4	52.0	48.0	53.9	46.4	50.1
Departure from Normal	-1.0	+3.3	+1.9	-2.1	+3.8	-3.7	-
Total Precipitation	2.43	0.59	2.01	0.17	4.25	3.01	1.83
Departure from Normal	+0.60	-1.24	+0.18	-1.66	+2.42	+1.18	-
Number of days of rain	8	2	6	1	10	10	-
April							
Average temperature	57.6	59.5	66.2	66.3	56.2	55.9	60.8
Departure from Normal	-3.2	-1.3	+5.4	+5.5	-4.6	-4.9	
Total Precipitation	5.43	0.42	0.53	2.24	2.71	2.22	2.98
Departure from Normal	+2.45	-2.56	-2.45	-0.74	-0.27	-0.76	-
Number of days of rain	15	2	2	7	13	10	-
May							
Average temperature	67.9	74.2	71.1	64.3	68.6	67.9	68.3
Departure from Normal	-0.4	+5.9	+2.8	-4.0	+0.3	-0.4	-
Total Precipitation	15.35	4.53	9.73	5.44	2.17	2.52	4.28
Departure from Normal	+11.07	+0.25	+5.45	+1.16	-2.11	-1.76	-
Number of days of rain	23	12	18	14	8	8	-
June							
Average temperature	75.2	79.6	74.3	78.7	84.0	81.3	77.9
Departure from Normal	-2.7	+1.7	-3.6	+0.8	+6.1	+3.4	-
Total Precipitation	9.60	1.79	3.42	2.49	2.67	2.45	4.14
Departure from Normal	+5.46	-2.35	-0.72	-1.65	-1.47	-1.69	-
Number of days of rain	18	5	8	7	5	7	-

from these records that certain monthly periods in previous years were cooler and wetter than in 1957, but that only in 1957 was the entire 4-month period cooler and wetter than the expected normal.

Stripe rust, like stem rust, does not overwinter in Oklahoma. Consequently the epidemic incidence of the disease is dependent more upon the conditions in Texas than in Oklahoma during the late winter months. The buildup of inoculum in that area this season was undoubtedly a result of a cool, wet winter.

OKLAHOMA STATE UNIVERSITY, STILLWATER, OKLAHOMA

STRIPE RUST OF WHEAT IN KANSAS IN 1957[1]

S. M. Pady, C. O. Johnston, and C. T. Rogerson[2]

Stripe rust (Puccinia striiformis West.)[3] was found on wheat for the first time in Kansas on May 29, 1957, by the authors during a rust survey trip. It was found in two fields in central Kansas in Saline and Dickinson Counties. The uredia were primarily epiphyllous in long lines or golden yellow streaks varying from 1 to 5 cm in length. A search revealed scattered infections, occurring usually as a single streak on flag leaves, but occasionally a leaf was found bearing up to seven or eight streaks. With rare exceptions the lesions were confined to the flag leaves. Laboratory examinations of the specimens confirmed that this was P. striiformis. A check of all available host indices, local lists, and herbarium specimens revealed that, as far as can be determined, this is the first time stripe rust has ever been collected in Kansas. Search was then made for this rust in other parts of the State. This paper summarizes the results of the surveys and also includes observations made by other workers.

On May 30 and 31, C. O. Johnston found stripe rust in Clay, Cloud, and Riley Counties in north-central Kansas. On June 1, Pady and Rogerson found the rust in Riley, Wabaunsee, Shawnee, and Pottawatomie Counties. A rust survey June 3 by the authors in central Kansas added six additional counties. A survey trip June 10 into northeastern Kansas was negative, even in fields where the foliage was green.

In a visit to Manhattan, June 5, Virgil Johnson, regional hard winter wheat improvement leader, reported that stripe rust was abundant in irrigated fields at the Branch Experiment Stations of Garden City and Hays, on June 3 and 4. He found traces of stripe rust in occasional fields (mostly irrigated) in southwestern Kansas from Liberal to Hays. Heavy leaf rust development and warm weather beginning June 3 resulted in drying of the foliage, and by June 12 stripe rust could not be found in central Kansas, even in the fields where it had been previously collected.

Stripe rust was collected in northwestern Kansas June 19 to 20 by C. T. Rogerson, on irrigated wheat in Wichita and Logan Counties and on non-irrigated wheat in Cheyenne County. E. G. Heyne reported the presence of this rust also in Thomas County on June 21.

Altogether, collections of stripe rust have been made in 17 counties and it has been reported in several additional counties. Its distribution is shown in the accompanying map (Fig. 1).

Since stripe rust is known to be a cool weather disease, usually prevalent in coastal and mountain regions, its presence in Kansas at a time when temperatures are normally high

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[2]Mycologist, Kansas Agricultural Experiment Station, Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and Assistant Mycologist, Kansas Agricultural Experiment Station, respectively.

[3][ED. NOTE: Under the provisions of the International Code of Botanical Nomenclature the correct name for this rust is P. striiformis West., but many workers will prefer P. glumarum Eriks. & E. Henn. on the basis of usage.]

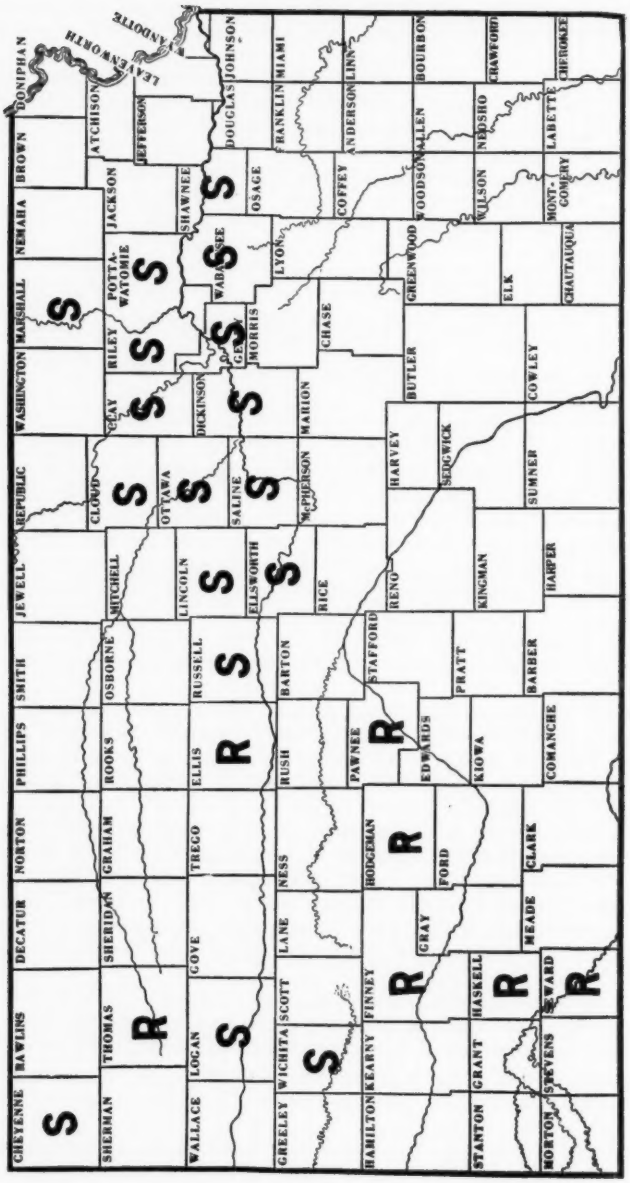

FIGURE 1. Distribution of stripe rust in Kansas in 1957.
S = Counties where collections were made.
R = Counties where stripe rust was reported.

Table 1. Weekly departure from normal temperature (T) and precipitation (P) at four stations in Kansas, for end of March to middle of June, 1957.

Week ending	Concordia		Topeka		Wichita		Goodland	
	T (°F)	P (inches)	T (°F)	P (inches)	T (°F)	P (inches)	T (°F)	P (inches)
March 31	- 5	-0.12	- 5	+1.25	- 3	+0.13	- 5	+0.40
April 7	-11	+2.41	- 9	+2.44	- 7	+0.05	-10	+1.04
14	-13	-0.31	-12	-0.56	-13	-0.78	-11	-0.35
21	+ 4	-0.22	+ 3	-0.61	+ 4	+0.27	+ 6	-0.36
28	+ 4	+0.77	+ 7	-0.35	+ 3	+0.23	- 1	+0.35
May 5	+ 1	+0.22	+ 1	-0.01	- 1	-0.12	+ 1	-0.26
12	- 2	+0.18	+ 1	-0.01	- 1	-0.11	- 2	+0.63
19	- 6	+2.08	- 3	+1.68	- 2	+3.13	- 8	+1.77
26	- 2	-0.21	- 1	-0.63	- 2	+0.16	- 7	+0.10
June 2	- 1	-0.43	0	-0.80	- 2	+0.71	- 1	+0.76
9	+ 2	-0.39	+ 1	-0.29	+ 2	-0.34	+ 4	-0.44
16	- 1	+1.10	- 8	-0.12	0	+1.32	- 6	+0.27

suggested that meteorological conditions must have been unusually favorable. Examination of meteorological data at four stations in Kansas was made. Table 1 gives data from the U.S.D.A. Weekly Weather and Crop Bulletin, for Concordia in north-central, Topeka in northeastern, Wichita in south-central, and Goodland in northwestern, Kansas.

Temperatures were below normal for the entire month of May at Wichita and all but the first five days of May at Concordia. At Topeka temperatures were slightly above normal until May 12, after which they were below normal for the remainder of the month. The week ending May 19 had unusually low temperatures over the State, with weekly departures as low as 6° below average, and widespread heavy rains which had probably provided the conditions necessary for stripe rust infection in north-central and northeastern Kansas. In northwestern Kansas, where the crop is much later, temperatures and moisture at Goodland were favorable for infection during May and again during the second week of June (Table 1). It is not known how long stripe rust had been in the State before it was discovered, but, since it was not seen in the rust surveys in April and early May, it is assumed that it came in between May 12 and 19 when weather conditions were unusually favorable.

DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, KANSAS AGRICULTURAL EXPERIMENT STATION, IN COOPERATION WITH CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AT MANHATTAN, KANSAS

SHORT NOTES CONCERNING STRIPE RUST IN OTHER STATES

NEBRASKA

By J. M. Daly

Stripe rust was first noticed in the Agronomy test plots at Lincoln by Virgil Johnson and John Schmidt during the first and second weeks in June 1957. Donald Fitchett, Jerry Bell, Robert Inman and J. M. Daly examined four fields in Lancaster County on June 14, and observed stripe rust in all four. Incidence and severity were only a trace. D. J. Fitchett and E. B. Lambert found stripe rust in trace amounts at York on June 27, at Kimball on June 29, and at Northport on June 29. John Weihing found traces of stripe rust as far west as Imperial on July 1. In general, leaf rust was so heavy that identification of stripe rust was difficult. Even though systematic observations were not made it seems probable that stripe rust occurred throughout Nebraska in trace amounts.

(NEBRASKA AGRICULTURAL EXPERIMENT STATION)

SOUTH DAKOTA

By J. G. Hennen

Collections of stripe rust were made by Dr. E. B. Lambert and Mr. D. J. Fitchett from winter wheat at Martin in the southwestern part of South Dakota on July 2, 1957, and at Brookings in the east-central region on July 3. No collections were made from spring wheat or barley. Heavy leaf rust infections made stripe rust detection difficult later in the season.

(SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION)

COLORADO

By E. A. Lungren

In a letter, Mr. Lungren reported that he had not seen any stripe rust in Colorado in 1957, nor had he received reports of the rust from any cooperators.

(COLORADO AGRICULTURAL EXPERIMENT STATION, COOPERATIVE WITH UNITED STATES DEPARTMENT OF AGRICULTURE)

WYOMING

By J. R. Vaughn

Stripe rust occurred in epidemic proportions in 1957 at Laramie on the Agronomy farm. This area is primarily a range area and the only wheat is grown at the Agronomy farm and two or three locations adjacent to it. There may have been traces of rust in other parts of the State but it is certain that no serious occurrence was present this year. The reason for the epidemic at Laramie is that spring wheat is much later than in any area nearby and the high altitude insures cool nights. In addition, there was almost twice the normal summer rainfall which no doubt made conditions ideal for infection and buildup to epidemic proportions. Stripe rust was first noted at Laramie in mid-July by Virgil A. Johnson and Bernard J. Kolp. By the latter part of August infection had reached epidemic proportions on susceptible varieties throughout the farm.

Notes were taken by Dr. Kolp in the State and regional spring wheat nurseries (see Table 1 on following page). The most susceptible variety was Onas. This variety had almost 100 percent severity wherever notes were taken except in the chemical rust control plots. It is interesting to note that in these plots several chemicals gave an excellent degree of control of black stem rust (which was also present in epidemic amounts) but only a very slight degree of control against stripe rust.

(UNIVERSITY OF WYOMING)

Table 1. Percent of stripe rust on wheat varieties in the 1957 State and Regional Spring Wheat Nursery at Laramie, Wyoming.[a]

Variety	C.I. No.	Rep I	Rep III
		%	%
Frontana x Thatcher	13030	2	2
Mindum	5296	2	2
Langdon	13165	10	5
Towner	13247	0	0
Ramsey	13246	0	0
Willett	13099	2	0
Yuma	13245	5	5
Pilot	11945	0	0
Cadet	12053	2	0
Mida	12008	0	0
Rushmore	12273	0	0
Marquis	3641	0	0
Thatcher	10003	0	0
Selkirk	13100	0	0
Lee	12488	0	0
Reward x Ill. 1-Chinese-T. timo.	13406	2	0
" "	13407	2	0
Conley	13157	0	0
ND2350 x Tha.-K338AC	13223	2	2
K228AA x ND2350	13224	0	2
K338AA x NS3880.191	13301	0	2
K338AA	13302	5	10
Thatcher x Kenya Farmer	13211	0	0
ND4 x NS3880.227	13317	5	10
K338AA x NS3880.191	13319	5	5
Rushmore x Kenya Farmer	13320	0	0
Lee x ND34	13322	2	5
ND4 x Lee	13324	2	2
II-44-29 x Lee	13325	2	2
" "	13401	0	0
Thatcher x Kenya Farmer	13402	5	2
II-44-29 x Lee	13404	0	0
Tim. x Henry	13405	0	0
Thatcher x RL2564	13332	0	0

[a]Notes taken Aug. 26, 1957

FURTHER OBSERVATIONS ON RACES OF CROWN RUST ATTACKING THE OAT VARIETIES LANDHAFER AND SANTA FE[1]

M. D. Simons, H. H. Luke, W. H. Chapman,
H. C. Murphy, A. T. Wallace, and K. J. Frey[2]

Abstract

The more important observations of the writers on the "Landhafer races" of crown rust during the past few years are summarized. No source of seedling resistance was found among the 5,000 lines of cultivated oats in the World Oat Collection, but good resistance was found among lines of diploid and tetraploid oats. Approximately 115,000 seedlings derived from irradiated material were tested for reaction to race 264, and all were susceptible.

Limited epiphytotics of Landhafer races occurred in the vicinity of Gainesville, Florida (mainly the previously undescribed race 290), and of Quincy, Florida (mainly race 264), in 1957. C. I. 7233 (tetraploid) and C. I. numbers 7171 and 7172 (hexaploids) were outstanding for adult plant resistance among entries of the 1957 Uniform Oat Rust Nursery at Quincy. A light infection of Landhafer races was present in Illinois, Indiana, Ohio, Wisconsin, Michigan, and Iowa later in 1957. Landhafer races were not isolated from crown rust collected from Landhafer derivatives in Texas and Kansas.

INTRODUCTION

Over the years, crown rust (caused by Puccinia coronata Cda. var. avenae Fraser & Led.) has been the most serious disease of oats in the major oat-growing regions of the United States, and the only practical means of control has been through the development of resistant varieties. Within recent years two varieties, Landhafer and Santa Fe, both originally from South America, have been widely used because of their crown rust resistance in breeding programs in the United States. Prior to 1953 these two varieties were regarded as resistant to all races and biotypes of crown rust in North America, but during that year (5) race 263 was identified from material collected in Manitoba, Canada. The following year races 264 and 276 were identified from Alabama and Iowa, respectively (7). These three races, which attack both Landhafer and Santa Fe, were apparently very rare, and were not seen in the United States in 1955. Races 263 and 276 were reported from Canada in 1956 (3). Preliminary testing (5) indicated that all the better-known sources of resistance among the cultivated oats were susceptible as seedlings to at least one of these races, but that certain strains of diploid and tetraploid oats were highly resistant (8).

For the sake of brevity, all these races will be referred to usually as the "Landhafer races" throughout the remainder of this paper.

GREENHOUSE TESTING

In an attempt to locate sources of resistance among the cultivated oats which could be

[1]Cooperative investigation of the U. S. Department of Agriculture, Agricultural Research Service, Crops Research Division, and the Agricultural Experiment Stations of Iowa and Florida. Journal Paper No. J-3297 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1176. The writers wish to acknowledge their indebtedness to the many people who supplied information and furnished crown rust collections for identification.

[2]Pathologists, Crops Research Division, Agricultural Research Service, United States Department of Agriculture; Agronomist, Florida Agricultural Experiment Station; Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture; Associate Agronomist, Florida Agricultural Experiment Station; and Associate Professor, Iowa Agricultural Experiment Station; respectively.

readily used in breeding programs, about 5,000 entries of the World Oat Collection[3] were tested in the seedling stage for reaction to race 264 under greenhouse conditions. This testing was carried out during the winter in Iowa with special precautions being observed to prevent inoculum from escaping to the field. No satisfactory source of seedling resistance was found among the hexaploid oats.

A number of strains of oats which were susceptible as seedlings have been shown to possess resistance to common races of crown rust as older plants under field conditions (6). Therefore, an attempt was made to determine the reactions of some of these in the heading or later stages of growth to race 264 in the greenhouse. The results were somewhat erratic and were not regarded as completely reliable, but did indicate that adult plant reaction to the Landhafer races warranted further study.

Recent reports (1, 2, 4) have shown that artificial irradiation may be used to induce mutations in oats for resistance to stem rust. With these findings in mind, seed of the variety Mo. 0-205 was irradiated[4]. Part of the seed received X-ray and part thermal neutron treatment. Approximately 115,000 seedlings of the X_2 generation were tested for reaction to race 264 under greenhouse conditions. Chlorophyll mutations were common, and a few seedlings appeared to be moderately resistant. All that were suspected of being resistant were immediately re-tested and invariably proved to be susceptible. The apparent resistance evident in the initial tests was probably the expression of the disease in plants weakened by root rotting or other causes.

EPIPHYTOTIC IN FLORIDA

Early in 1957 susceptible-type uredia were observed in Florida on varieties of oats carrying the Landhafer and Santa Fe genes for crown rust reaction. At Gainesville, Florida, this infection appeared as an isolated pocket, apparently being confined to a single experimental field. Crown rust had not been released artificially anywhere in the Gainesville area, but natural infection of common races was heavy on all susceptible varieties. Crown rust on the Landhafer and Santa Fe derivatives ranged from moderately severe in one corner of the field to very slight in other parts. The relatively small area of heavy infection was quite distinct, indicating that all the infection had probably arisen from a single early infection.

Rusted leaves of the Landhafer and Santa Fe varieties were collected at Gainesville, and the rust was later identified as to race in the greenhouse at Ames, Iowa. Reactions of the standard ten differential varieties indicated that a single, homogeneous race (Table 1) was involved. This race strongly parasitized the varieties Appler, Bond, Landhafer, and Santa Fe. Anthony was moderately susceptible. The remaining differential varieties, Victoria, Ukraine, Trispernia, Bondvic, and Saia, were highly resistant, showing flecking reactions accompanied by virtually no sporulation. As no previously described race was known that fit this description, this race was regarded as new and was assigned number 290. It should be emphasized that race 290 differs very sharply from the Landhafer races previously seen in North America (263, 264, and 276) by its inability to parasitize Trispernia and Bondvic. The purified stocks of these varieties now in use are fully susceptible to races 263, 264, and 276, but are clearly resistant to all other North American races.

Landhafer and Santa Fe varieties also exhibited susceptible-type infection in the vicinity of Quincy, Florida. Here, as at Gainesville, crown rust had not been artificially released, but natural infection of common races was very heavy. The races attacking Landhafer and Santa Fe, however, were rather widespread and much more general in occurrence at Quincy than at Gainesville. No single center of infection was detected. Infection was moderately severe throughout the nursery, and a field of Seminole oats (a Santa Fe derivative) some distance from the nursery was seriously damaged. It was observed both at Quincy and Gainesville, especially at Gainesville, that Landhafer races were less virulent on Landhafer and Santa Fe derivatives than were the more common races on varieties they parasitized. This may indicate that the Landhafer races are not so potentially dangerous as was first thought, but it should also be remembered that new, potentially dangerous races reported in the past

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[3]Seed of the World Oat Collection was furnished by Mr. D. J. Ward, Cereal Crops Research Branch, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

[4]The writers wish to express their appreciation to personnel of the Brookhaven National Laboratory, Upton, Long Island, New York, for radiating the seed.

Table 1. Reactions[a] of the standard crown rust differential varieties to North American races of crown rust parasitizing the oat varieties Landhafer and Santa Fe.

Differential variety	Race				
	263	264[b]	276[b]	290	293[c]
Anthony	S	S	S	S	R
Victoria	R	S	R	R	R
Appler	S	S	S	S	S
Bond	S	S	S	S	S
Landhafer	S	S	S	S	S
Santa Fe	S	S	S	S	S
Ukraine	R	S	S	R	R
Trispernia	S	S	S	R	R
Bondvic	S	S	S	R	R
Saia	R	R	R	R	R

[a]"R" indicates resistance and includes reaction types I, 0, 1, and 2; "S" indicates susceptibility and includes reaction types 3 and 4.
[b]Races 264 and 276 are very similar, and the distinction between them is not always clear.
[c]Race 293 was first discovered by Dr. B. Peturson in Canada. It is very similar to race 290.

were, in several instances, first regarded as lacking aggressiveness. Some of these later became extremely aggressive.

Crown rust collections made at Quincy were later identified and shown to differ from the rust at Gainesville. With one possible exception, all the isolates attacking Landhafer and Santa Fe were race 264. One isolate was tentatively identified as race 263, but this identification has not been confirmed.

REACTIONS OF OAT VARIETIES

The occurrence of race 264 in the nursery at Quincy, which included the 1957 Uniform Oat Rust Nursery, afforded an opportunity to study the reactions of many potential sources of resistance under field conditions (Table 2). Unfortunately, the abundance of other races, including races attacking Victoria and races attacking Saia, tended to obscure the reactions of certain lines to race 264.

While there was no question about the susceptibility of the parental varieties Landhafer and Santa Fe, these varieties were not so heavily infected as were most of the agronomic varieties derived from them. These derivatives are known, in most cases, to carry the major gene or genes for resistance found in their respective parents, but apparently lack modifying or minor genes carried by their parents. The varieties Trispernia and Bondvic were even more heavily infected than most of the Landhafer and Santa Fe derivatives.

Although there were some susceptible type uredia on Saia, which is known to be susceptible in the seedling stage to a few rare races, there is no doubt that this variety is almost immune from all the North American races attacking Landhafer. Saia, however, belongs to the diploid species Avena strigosa, and consequently the incorporation of its genes conditioning resistance into cultivated varieties of oats will not be simple. Ceirch du Bach (C. I. 2923) is a hexaploid oat that is mentioned in connection with Saia because it is susceptible in the seedling and adult stages of growth to at least some of the races that attack Saia. It sometimes exhibits an

Table 2. Reactions[a] of key varieties of oats to crown rust under field conditions (all natural infection) at Quincy, Florida, in 1957.

C.I. no.	Name or origin	Severity (%)	Reaction type
2053	Markton	100	S
7002	Victoria	30	S
7004	Bond	80	S
7005	Landhafer	10	MS-S
6913	Minhafer	30	MS-S
6935	Landhafer x (MxHJ) x Cl.	50	S
7006	Santa Fe	20	S
5924	Semincle	80	S
7007	Ukraine	20	MS-S
7008	Trispernia	60	S
7009	Bondvic	70	S
7010	Saia	5	MR-MS
7233	A. abyssinica (PI 193958)	tr	R
7146	Ascencao	10	MS-S
7147	S.E.S. 52-147 (PI 174545)	10	MS-S
2923	Ceirch du Bach	70	S
7171	Selecta D.L. 41372	tr	R
7172	D.L.M. 3	tr	R

[a]Severity refers to the percentage of leaf area covered by uredia in terms of the modified Cobb scale; "S" indicates complete susceptibility; "MS" moderate susceptibility; "MR" moderate resistance; and "R" resistance.

intermediate seedling reaction to other races, including race 264, and is believed to possess a high degree of adult plant resistance to these other races. Under Iowa conditions it is extremely susceptible to a presumably non-parasitic leaf blight, and few varieties were worse from an agronomic standpoint. The heavy crown rust observed on it at Quincy was believed to consist of Saia races. Race 264 was not isolated from material collected from Ceirch du Bach. The only race that was isolated was race 234, a race which attacks Saia.

C. I. 7233 (Avena abyssinica, P. I. 193958) showed good resistance at Quincy. In the seedling stage under greenhouse conditions, it shows a strong flecking reaction to race 264, with little or no sporulation. Unfortunately, the use of this line as a source of resistance is complicated because of its tetraploid chromosome constitution. It also appears to be susceptible to at least some of the common biotypes of the races attacking Victoria, such as race 216.

Two hexaploid oats, designated C. I. 7171 (P. I. 185783) and C. I. 7172 (P. I. 197278), were highly resistant at Quincy. They do not always appear to be this resistant at other locations, and are susceptible in the seedling stage to all races to which they have been tested. They are probably resistant to the Landhafer races but appear to be susceptible to at least some biotypes of other races under field conditions. Their resistance is influenced by

environmental conditions and tends to break down late in the season or in unusually hot weather. Although they are very poor from the agronomic point of view, the writers have found them to cross readily with common adapted varieties. C. I. 7147 (P. I. 174545) may be an additional source of adult resistance to the Landhafer races but was moderately susceptible at Quincy, and is usually appreciably more susceptible to common races in the field than C. I. numbers 7171 and 7172.

OCCURRENCE OF LANDHAFER RACES IN OTHER STATES

The resistance of both Landhafer and Santa Fe, and of their derivatives, often shows a tendency to break down in the field. This is most pronounced late in the season and when temperatures are unusually high. Some biotypes of crown rust, especially those comprising certain Victoria races, such as race 216, may appear to parasitize these varieties rather effectively under these conditions. There is good reason to think, however, that the inoculum initiating this type of infection is produced mainly on susceptible varieties, that infection occurs too late to affect yield seriously, and that damage would be very slight if large fields of the resistant variety were grown at some distance from susceptible varieties. Nevertheless, it is sometimes very difficult to distinguish between these late field reactions and truly susceptible reactions.

During the spring and early summer of 1957, a number of reports regarding the occurrence of the Landhafer races were received from widely scattered States. Some of the crown rust collected from the varieties in question was tested for ability to attack Landhafer in the seedling stage at Ames, Iowa. Such tests on material from Texas and Kansas were negative. Most of these rust collections did attack seedling plants of Victoria. Collections made in Indiana, however, were shown to be strongly pathogenic to Landhafer, and careful observations made in the field indicated that crown rust parasitizing Landhafer varieties was fairly common in Indiana and Ohio. It also occurred in readily detectable amounts in Illinois, Michigan, and Wisconsin, and was found in a field of volunteer Clintland (a Landhafer derivative) in Iowa late in the summer. Crown rust from the infected Clintland in Iowa, and also from late-planted material of the same variety in Wisconsin, was identified as race 290 or 293[5]. In terms of severity, infection of Landhafer races in these northern States was light and spotty, and economic damage was probably negligible. However, the wide distribution of these races indicates that they may be well established and in a position to increase rapidly under the proper conditions.

DISCUSSION

At present the potential threat of the Landhafer races makes further attempts to develop or locate sources of resistance highly desirable. Now that these races are present in appreciable amounts in nature, adult plant resistance can be given more attention. Additional work might reveal sources better than any now available. Any such sources discovered should be studied to determine reactions to biotypes of other races and the interactions of reactions to various races with different environmental conditions.

Unfortunately, little is known about the numerous factors involved in inducing disease resistance by means of radiation. For example, we do not know what kind or amount of radiation is most efficient for induction of resistance to a specific disease. Neither do we know what varieties or genotypes are most amenable to change in the desired direction, nor whether interactions between various factors exist. Consequently, the failure of the writers to obtain resistance by radiation should in no sense be interpreted as discouraging further work along this line. The possibility that radiation might produce a gene for crown rust resistance greatly superior to any presently available has not been lessened, and is worthy of much more extensive investigation.

One more possibility, which the writers have not investigated, is that of combining previously known genes for resistance to crown rust. It has been shown (9) that certain genes in combination furnish a higher degree of resistance to common races of crown rust than the same genes alone furnish. Perhaps there are certain combinations of available genes, which, by complementary or cumulative effects, will condition resistance to the Landhafer races.

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[5]Crown rust race 293 was first identified by Dr. B. Peturson in Canada. It is very similar to race 290, and the distinction between the two is not always clear.

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CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, IN COOPERATION WITH THE IOWA AND FLORIDA AGRICULTURAL EXPERIMENT STATIONS

PHYSIOLOGIC RACES OF CROWN RUST OF OATS IDENTIFIED IN 1956-57[1]

M. D. Simons[2]

DESCRIPTIONS OF NEW RACES

Since the last compilation of previously unnumbered races of crown rust (Puccinia coronata Cda. var. avenae Fraser and Led.) was made[3], the discovery of four new races has been brought to the attention of the author. Reactions of the 10 standard crown rust differential varieties to these races are shown below.

Race	Variety									
	Anthony	Victoria	Appler	Bond	Landhafer	Santa Fe	Ukraine	Trispernia	Bondvic	Saia
290	S	R	S	S	S	S	R	R	R	R
291	R	S	S	R	R	R	R	Int.	Int.	R
292	S	S	S	R	R	R	R	Int.	Int.	R
293	R	R	S	S	S	S	R	R	R	R

Race 290 was discovered in the United States early in 1957 by Simons et al.[4], races 291 and 292 in Argentina by Cenoz[5], and race 293 in Canada in 1957 by Peturson[6]. A comparison of more detailed descriptions of races 290 and 293 indicated that they were probably very closely related. They are of special interest because they were found in North America and severely infect the ordinarily resistant varieties Landhafer and Santa Fe. They differ sharply from North American races earlier reported to attack these varieties (263, 264, and 276) by their inability to parasitize Trispernia and Bondvic.

Race 289, which was first identified in New Zealand, was incorrectly described by this writer in a previous paper (see footnote 3). It was stated that Anthony was susceptible. Anthony is actually resistant, as are all the other differential varieties except Appler and Saia, which are susceptible.

PREVALENCE AND DISTRIBUTION OF RACES IDENTIFIED IN 1956

A total of 394 collections of crown rust on oats made in 28 States or comparable areas in 1956 were received at Ames, Iowa. This was about the same number as were received in 1955. All collections containing viable urediospores were increased on the extremely susceptible variety Markton, and then used to inoculate the standard set of ten differential varieties. Observation of infection on the differentials showed that many of the collections represented mixtures of different races of crown rust. Ordinarily, single pustule isolates were made from such mixtures; however, the component races of nine of these mixed collections

[1]Cooperative investigation between the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Iowa Agricultural Experiment Station. Journal Paper No. J-3298 of the Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa. Project No. 1176. The writer wishes to acknowledge his indebtedness to the investigators in other countries who have generously made their data available, and to those in the United States who have supplied crown rust collections for identification.

[2]Plant Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

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[5]Unpublished data furnished by H. P. Cenoz, 1957.

[6]Unpublished data furnished by B. Peturson, 1957.

Table 1. Physiologic races of Puccinia coronata avenae isolated from oats in 1956.

Area and location	Prevalence and distribution of physiologic races:																						Total	
	201	202	203	205	211	212	213	216	226	231	235	237	238	239	241	258	259	264	274	279	280	284	285	Isolates	Races
NORTH CENTRAL																									
Illinois		12	2				7	6												2				29	5
Indiana		4	3				2	4																13	4
Iowa		26	4	1	1	1	17	4				1			1								1	57	10
Kansas		3	3	1			2	3							1	1								14	7
Manitoba																		2						2	1
Michigan	2	16	1				4																	23	4
Minnesota		6	2	3			2	2				1				1								17	7
Missouri		1	2				2	1																6	4
Nebraska	1						1																	2	2
North Dakota		2	2				2	2	1	1					1			1						12	8
Ohio	1	7	4				4	6				1								1				24	7
South Dakota		5	2				3	2		1		1								1				15	7
Wisconsin	1	11	15				2	6						1										36	6
Total	5	93	40	5	1	1	48	36	1	2		4		1	3	2		3		4			1	250	17
Percent	2.0	37.2	16.0	2.0	.4	.4	19.2	14.4	.4	.8		1.6		.4	1.2	.8		1.2		1.6			.4		
EASTERN																									
New York	2	2	1			2	2	1													1	2		13	8
Pennsylvania		14	3	1			3	2				1												24	6
Total	2	16	4	1		2	5	3				1									1	2		37	10
Percent	5.4	43.2	10.8	2.7		5.4	13.5	8.1				2.7									2.7	5.4			
SOUTH CENTRAL																									
Arkansas			1					1																2	2
Kentucky		1	2					1																4	3
Louisiana	3	9	4	1				1																18	5
Mexico		1					1						1						1					4	4
Mississippi	1	4					7													1				13	4
Oklahoma								1				1												2	2
Tennessee		3		2			1				1													7	4
Texas	1	18	4				19	14				3				2			3	5				69	9
Total	5	36	11	3			28	18			1	4	1			2			4	6				119	12
Percent	4.2	30.2	9.2	2.5			23.5	15.1			.8	3.4	.8			1.7			3.4	5.0					
SOUTHEASTERN																									
Alabama	1	1														1								3	3
Florida		4	7				1	9				1							1					23	6
Georgia		4		1			3	4								1			1					14	6
South Carolina		4	2	1			4	6								4	1							22	7
Virginia	1	3	3	1			2	1				1	1			1								14	9
Total	2	16	12	3			10	20				2	1			7	1		2					76	11
Percent	2.6	21.1	15.8	3.9			13.2	26.3				2.6	1.3			9.2	1.3		2.6						
Grand Total	14	161	67	12	1	3	91	77	1	2	1	11	2	1	3	11	1	3	6	10	1	2	1	482	23
Percent	2.9	33.4	13.9	2.5	.2	.6	18.9	16.0	.2	.4	.2	2.3	.4	.2	.6	2.3	.2	.6	1.2	2.1	.2	.4	.2		
Locations	10	24	20	9	1	2	22	21	1	2	2	9	2	1	3	7	1	2	4	5	1	1	1		
Areas	4	4	4	4	1	2	4	4	1	1	1	4	2	1	1	3	1	1	2	2	1	1	1		

were never positively identified.

The 482 isolates that were identified were distributed among 23 races (Table 1). As in all previous years since the new standard set of ten differential varieties has been used, race 202 was the most common, accounting for 33 percent of all isolates. This was somewhat less than in 1955, but was about the same as in 1954. Race 202 attacks the varieties Anthony, Appler, and Bond. The remaining differentials, Victoria, Landhafer, Santa Fe, Ukraine, Trispernia, Bondvic, and Saia, are resistant. Race 203, which differs from race 202 only by its ability to attack Ukraine, constituted 14 percent of the total, and was fourth in prevalence. In past years it has been the second most common race.

Races 213 and 258 together constituted 21 percent of the total. These two closely related races attack Victoria, ordinarily inducing a moderately susceptible to susceptible reaction on this variety in the greenhouse. Race 216, to which Victoria usually appears to be extremely susceptible, accounted for 16 percent of the total. All Victoria races combined comprised 44 percent of the total. This represents an appreciable increase over the comparable figure of 18 percent for 1955. In 1954 and 1955, the Victoria races were relatively more prevalent in the Southeastern States than elsewhere. In 1956, this trend was still apparent but was less pronounced.

The extremely virulent race 264, which attacks all of the differential varieties except Saia, was found in two collections from Manitoba and one from North Dakota. This was the first time a race attacking Landhafer and Santa Fe had been found in the United States since 1954.

The remaining races that were identified from material collected on oats were all rather uncommon, and none of them was of special interest in terms of pathogenicity.

Most of the aecial collections that were received in 1956 were lost because of unfavorable weather conditions. All those that were identified were from the North Central States, and contained only common races that were of no special significance.

CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND IOWA AGRICULTURAL EXPERIMENT STATION, AMES, IOWA

TWO METHODS OF COLLECTING RUST UREDIOSPORES IN THE FIELD[1]

L. J. Petersen, N. R. Gerhold, and A. R. Weinhold[2]

INTRODUCTION

The collection of urediospores of Puccinia graminis f. sp. tritici Erikss. & Henn., P. rubigo-vera f. sp. tritici (Erikss.) Carleton, and other plant rusts in adequate quantities in the field or greenhouse frequently presents a problem to plant pathologists. This paper describes two spore collecting devices: one, a wheel-mounted, gasoline-powered pump unit, the other, a portable electric vacuum cleaner unit powered by two flashlight batteries. Both utilize a cyclone separator microorganism collector (2) and are capable of collecting several hundred milligrams of urediospores per hour.

DESCRIPTION

In August, 1956, an attachment to collect urediospores of the wheat stem rust organism was fitted to a Spartan Sprayer. This apparatus (Fig. 1) consisted of a wheel-mounted, gasoline-powered pump, a pressure-regulator, aspirator, and cyclone separator microorganism collector. This unit proved to be an efficient collecting device for urediospores of cereal rusts. The water pump (A) circulates water through the aspirator (C) which provides the necessary suction through hose (D) to operate the cyclone separator (F). In order to protect the urediospores from excessive moisture it was found necessary to install a water trap (C) in the suction line. The unit operated most efficiently at pressures below 50 pounds since excessive debris was taken into the collector at higher pressures. Utilizing severely infected plants, several hundred milligrams of urediospores per hour may be collected. It was found that for best results the length of the suction line (D) should not exceed 15 feet.

While the aforementioned apparatus proved to be very efficient, lack of portability limited its usefulness. It could only be used in fields having relatively smooth terrain. Consequently a small, portable, inexpensive collector was devised similar to an eriophyid mite collector described by Quist (1). The modified spore collector (Fig. 3) consists of an electric vacuum brush (obtainable from most large dry goods stores) and a cyclone separator microorganism collector fitted with a plastic centrifuge tube.

Construction of the spore collector was relatively simple (Fig. 2). The bristles were removed from the lucite vacuum brush and the intake port covered with plastic and cemented in place (C). A 1/4-inch hole was then drilled into the center of the plastic cover to receive a 2-inch section of 1/4-inch flexible tubing (D). The cyclone separator with plastic centrifuge tube (E) was attached to the 1/4-inch tubing. It was found after prolonged use that accumulation of spores in the intake tube occurred unless care was taken to prevent it. Gently tapping the intake tube or inserting a pipe cleaner was all that was necessary to dislodge any obstruction.

The efficiency, low cost, and portability of this device shows promise of fulfilling the need for large-scale urediospore collections. In addition the small size of the pickup tube makes it possible to collect urediospores from a single sorus, thus excluding undesirable sori.

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[1]Published with the approval of the Director, Colorado Agricultural Experiment Station as Scientific Series Paper No. 531.
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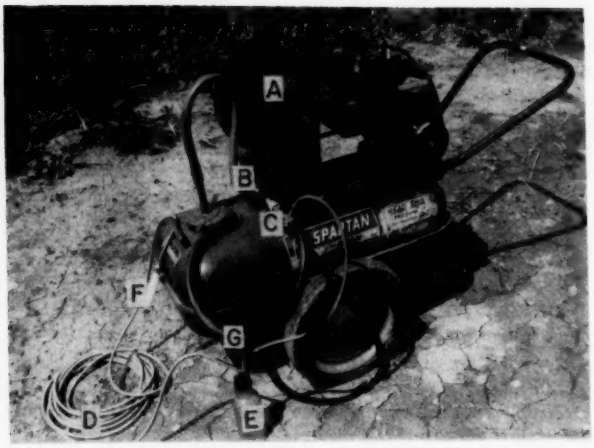

FIGURE 1. Wheel mounted, gasoline-powered spore collecting apparatus showing pump (A), pressure regulator (B), aspirator (C), suction hose (D), water trap (E), cyclone separator (F), and return flow line (G).

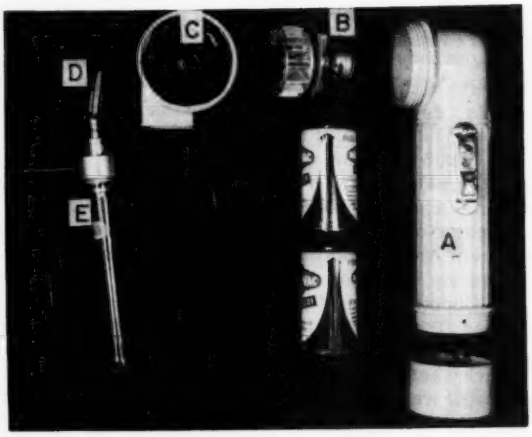

FIGURE 2. Battery-powered spore collector showing battery case (A), electric motor and turbine (brushes removed), 1/4 inch plastic suction line (D), cyclone separator microorganism collector with storage tube (E).

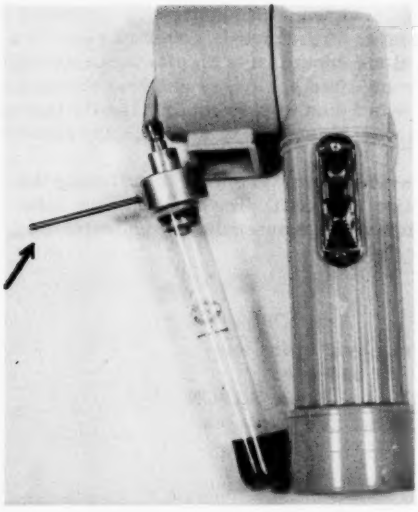

FIGURE 3. Battery-powered spore collector assembled ready for use. Arrow points to spore intake tube.

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RACE 20 OF USTILAGO TRITICI[1]

T. A. Gaskin, Ralph M. Caldwell, Leroy E. Compton, and John F. Schafer[2]

A culture of wheat loose smut (Ustilago tritici (Pers.) Rostr.) maintained at Purdue University since 1938 is distinct from the previously described races. This culture attacks only Purdue No. 1 (C. I. 11380) of the differential varieties of Bever[3] and is here designated as race 20. Table 1 presents the average infection in a recent greenhouse test and in earlier field tests except for the varieties Early Premium and Leap, which were tested only in the greenhouse.

Table 1. Average percentage of smutted heads in the differential winter wheat varieties inoculated with race 20 of Ustilago tritici.

Variety	Percent smut	Variety	Percent smut
Wabash (C. I. 11384)	0.5	Nabob (C. I. 8869)	0.9
American Banner (C. I. 6843)	0.0	Forward (C. I. 6691)	0.0
Purdue No. 1 (C. I. 11380)	43.5	Trumbull (C. I. 5657)	0.0
Hussar (C. I. 4843)	0.4	Kangip (C. I. 13097)	0.0
Early Premium* (C. I. 11858)	0.0	Leap* (C. I. 4823)	0.0

*Test conducted only in the greenhouse.

In attacking only Purdue No. 1 of the differential varieties, race 20 is distinctly different from the other races. The original collection was obtained from Purdue No. 1 in 1938 at Lafayette, Indiana, and since that time it has been maintained on this variety by annual inoculation. The long period of serial passage through this one variety may have resulted in the selection of a culture with the specific ability to attack only Purdue No. 1. In early field tests some of the other differentials were slightly susceptible; for example, up to 7 percent infection in Hussar. In more recent tests these varieties showed no smut.

With its narrow host range, this race is not of economic importance. Besides Purdue No. 1, only the variety Gladden is known to be susceptible.

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[2]Graduate Student and Pathologist, Purdue University; Agronomist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture; and Pathologist, Purdue University.

[3]Bever, W. M. 1953. Further studies on physiologic races of Ustilago tritici. Phytopathology 43: 681-683.

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RESULTS OF REGIONAL SEED TREATMENT TESTS FOR THE CONTROL OF SEED-BORNE AND SOIL-BORNE COMMON BUNT OF WINTER WHEAT IN THE PACIFIC NORTHWEST FOR THE YEAR 1957[1]

Laurence H. Purdy[2]

Summary

Regional tests for the control of seed-borne and soil-borne common bunt of winter wheat by seed treatment were made in the Pacific Northwest. Twenty-eight chemical formulations were tested which included 19 mercurials, eight formulations of hexachlorobenzene (HCB), and one formulation of pentachloronitrobenzene (PCNB). Data were obtained from eight different locations.

Relatively good control of seed-borne and soil-borne common bunt was obtained in all tests with the HCB formulations and in three of the five types of tests with PCNB. The mercurials generally gave good control of seed-borne bunt, except Mema-sol and PMA plus Heptachlor which gave poor control. Mercury seed treatment, however, failed to control bunt originating from soil-borne spores.

INTRODUCTION

A series of regional seed treatment tests for the control of common bunt (Tilletia caries (D. C.) Tul. and T. foetida (Wallr.) Liro) of winter wheat in the Pacific Northwest was begun in 1954 to provide information on the effectiveness of commercially available seed treatment fungicides under a wide range of environmental and geographical conditions. Information gained from these tests in 1955[3] and 1956[4] shows that recommendations for seed treatment fungicides can be made on a regional basis. Continued good performance of any material in these regional tests is the basis for its recommendation as a seed treatment for wheat smut control. Thus, the continuation of these tests serves not only as a check on the established formulations but also as a means of providing data on the performance of experimental materials.

MATERIALS AND METHODS

Twenty-eight chemical formulations were tested at nine[5] locations in Idaho, Montana, Oregon, Utah, and Washington. The results obtained from the test in Kalispell, Montana, were not usable because of the presence of volunteer wheat in the plots. The materials tested are listed below with their respective active ingredients and manufacturers, whose addresses are also included.

Anticarie	40% hexachlorobenzene. H. D. Rossiger & Co., Inc., New York, N. Y.

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[1]Cooperative investigation of the United States Department of Agriculture, Agricultural Research Service, Crops Research Division, and the Agricultural Experiment Stations of Idaho, Montana, Oregon, Utah, and Washington.

[2]Pathologist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture, Pullman, Washington. Scientific Paper No. 1678 Washington Agricultural Experiment Station, Pullman, Washington.

[3]Purdy, L. H. 1955. Regional seed treatment tests for the control of seed-borne and soil-borne common smut of winter wheat in the Pacific Northwest. Plant Dis. Reptr. 39: 844-849.

[4]Purdy, L. H. 1956. Regional seed treatment tests for the control of seed-borne and soil-borne common smut of winter wheat in the Pacific Northwest for the year 1956. Plant Dis. Reptr. 40: 996-1000.

[5]Grateful acknowledgement is extended to the cooperators at the indicated locations who assisted in these tests: Bozeman, Montana (Dr. E. R. Hehn); Kalispell, Montana (W. W. Mawritsen and V. R. Stewart); Genesee, Idaho (C. Herman); Moscow, Idaho (Drs. A. M. Finley and W. K. Pope); Worley, Idaho (E. W. Bitters); Moro, Oregon (W. E. Hall); Pendleton, Oregon (Dr. C. R. Rohde); Logan, Utah (Dr. W. G. Dewey); Lind, Washington (W. L. Nelson).

Cal Spray 80% HCB	80% hexachlorobenzene. California Spray-Chemical Corp., Richmond, California.
Captan + HCB 40-40	40% captan + 40% hexachlorobenzene. California Spray-Chemical Corp., Richmond, California.
Ceresan M	7.7% N-(ethylmercuri)-p-toluenesulfonanilide. E. I. du Pont de Nemours & Co., Wilmington, Delaware.
Ceresan 75	2.8% ethyl mercury 2,3-dihydroxypropyl-mercaptide and 0.6% ethylmercury acetate. E. I. du Pont de Nemours & Co., Wilmington, Delaware.
Ceresan 200	6% ethyl mercury 2,3-dihydroxypropyl-mercaptide and 1.3% ethylmercury acetate. E. I. du Pont de Nemours & Co., Wilmington, Delaware.
Chipman 80% HCB	80% hexachlorobenzene. Chipman Chemical Co., Bound Brook, New Jersey.
Mema	11.4% methoxyethylmercury acetate. Chipman Chemical Co., Bound Brook, New Jersey.
Mema-sol	23.85% methoxyethylmercury acetate. Chipman Chemical Co., Bound Brook, New Jersey.
Merculine 100	10% phenylmercury salicylate. H. L. Woudhuysen, New York, New York.
Mer-sol	7% phenylmercury acetate. Stauffer Chemical Co., North Portland, Oregon.
Metasan M	5.7% methylmercury oxyquinolate. Metalsalts Corporation, Hawthorne, New Jersey.
Metasol M[6]	2.7% methylmercury oxyquinolate. Metalsalts Corporation, Hawthorne, New Jersey.
Nq Bunt	40% hexachlorobenzene. Chipman Chemical Co., Bound Brook, New Jersey.
Panogen 15	2.2% cyano (methylmercury) guanidine. Panogen, Inc., Ringwood, Illinois.
Panogen 42	6.3% cyano (methylmercury) guanidine. Panogen, Inc., Ringwood, Illinois.
PMA + Heptachlor	1% phenylmercury acetate and 20% Heptachlor. California Spray-Chemical Corp., Richmond, California
Puraseed	6.25% N-phenylmercuriformamide and 6.25% anilinocadmium lactate. Gallowhur Chemical Corp., Ossining, New York.
RE-3681	8% hexachlorobenzene. California Spray-Chemical Corp., Richmond, California.

[6]Marketed by California Spray-Chemical Corp., Richmond, California, under brand name "Ortho LM Seed Protectant."

Sanocide	40% hexachlorobenzene. California Spray-Chemical Corp., Richmond, California.
Setrete	7% phenylmercury acetate. W. A. Cleary Corp., New Brunswick, New Jersey.
Smut B Gon 7%	7% phenylmercury acetate. California Spray-Chemical Corp., Richmond, California.
Smut B Gon 10%	10% phenylmercury acetate. California Spray-Chemical Corp., Richmond, California.
Smut Go	40% hexachlorobenzene. Miller Products Co., Portland, Oregon.
Tag #331	10% phenylmercury acetate. California Spray-Chemical Corp., Richmond, California.
Terraclor	75% pentachloronitrobenzene. Mathieson Chemical Corp., Baltimore, Maryland.
Velsicol Emmi (liquid)	10.34% 1,4,5,6,7,7-hexachloro-N (ethylmercuri) bicyclo [2.2.1] hept-5ene-2,3-dicarboximide. Velsicol Corp., Chicago, Illinois.
Velsicol Emmi (wettable powder)	10% active ingredient (as above).

The winter wheat variety, Orin, was used at all locations. The seed was inoculated with bunt spores and treated in units of 250 milliliters by the method described previously (see footnote 3). Treated seed was planted in randomized 10-foot rows, and there were three replications of each treatment at all locations. Bunt percentages were based on the total number of heads per row. Calculations of percentages and statistical analyses of the data were made by the Computing Center of the State College of Washington.

Statistical significance at the 5 percent level is indicated in the column so titled in Tables 1, 2, 3, 4, and 5. Treatments that are enclosed by an individual line do not differ significantly from each other, but are significantly different from those treatments outside the limits of that line.

RESULTS

The results from different locations showed a similar pattern, and for this reason analyses of data were based on the averages from all locations. The data obtained from tests on the control of seed-borne common bunt are summarized in Table 1.

A high incidence of bunt occurred in the untreated check rows, the average being 65 percent. Of the 28 different formulations tested, only three failed to provide adequate control. These were Mema-sol, PMA plus Heptachlor, and Terraclor. The remaining group of 25 fungicides consisted of 17 mercurials and eight formulations of hexachlorobenzene (HCB). Again, as in 1956, control was obtained with the phenylmercury derivatives, which were inferior to other mercury preparations in the 1955 tests. Because of this erratic performance, the phenylmercury preparations are considered unreliable for wheat smut control.

In an attempt to resolve the apparent differential effectiveness of HCB in controlling soil-borne smut in commercial and laboratory usage, two methods of planting the treated seed were employed. The first was similar to the method used in 1955 and 1956, in which open furrows were sprayed with a suspension of bunt spores, after which the seed was distributed in the furrows from seed envelopes. The furrows were then closed, first from one side and then from the other, to insure good distribution of the spores in the soil around the seed. In the other method, spores were sprayed on the soil surface before drilling the seed with a single-row seeder. This method was intended to simulate the commercial seeding process. In these tests both inoculated and uninoculated seed was used.

The results from the tests with uninoculated seed, planted in open furrows, are presented

Table 1. Summary of results of 8 regional seed treatment tests for the control of SEED-BORNE common bunt in winter wheat in the Pacific Northwest, 1957.

Treatment	Form	Ounces Per Bushel	Percent Bunt	Statistical Significance
Check - untreated			64.0	a
Mema-sol	Z[a]	1/8	18.5	b
PMA + Heptachlor (Cal. Spray)	L[b]	4 1/2	15.8	b
Terraclor	W[c]	1	10.3	b
Puraseed	W	1/2	8.3	b
Sanocide	W	1	7.7	b
Cal Spray 80% HCB	W	1/2	6.9	b
Chipman 80% HCB	W	1/2	6.9	b
Velsicol Emmi	W	1/2	5.2	b
Setrete	L	1/2	5.0	b
Mema	L	1/4	4.7	b
No Bunt	W	1	4.6	b
Mer-sol	L	1/2	4.2	b
Metasol M	L	3/4	3.9	b
Merculine 100	L	1/2	3.9	b
Captan + HCB 40-40	W	1	3.9	b
Smut B Gon 7%	L	1/2	3.8	b
Smut Go	W	1	3.2	b
Ceresan 75	L	3/4	3.1	b
Metasan M	W	1/2	3.0	b
Tag #331	L	1/2	2.9	b
Panogen 15	L	3/4	2.8	b
RE-3681	L	4 1/2	2.4	b
Smut B Gon 10%	L	1/2	2.3	b
Panogen 42	L	1/5	2.3	b
Ceresan M	W	1/2	2.2	b
Anticarie	W	1	2.1	b
Velsicol Emmi	L	1/2	1.4	b
Ceresan 200	L	1/4	1.4	b

[a]Water soluble solid
[b]Liquid
[c]Wettable powder

Table 2. Summary of results from 8 regional seed treatment tests for the control of SOIL-BORNE common bunt in winter wheat in the Pacific Northwest, 1957.

Treatment	Form	Ounces Per Bushel	Percent Bunt	Statistical Significance
Open Furrow Inoculation				
Check - untreated			51.4	
Panogen 15	L[a]	3/4	42.7	
Terraclor	W[b]	1	16.0	
RE-3681	L	4 1/2	10.2	
Sanocide	W	1	8.4	
Captan + HCB 40-40	W	1	7.7	
Chipman 80% HCB	W	1/2	7.5	
No Bunt	W	1	7.2	
Smut Go	W	1	7.1	
Anticarie	W	1	6.7	
Cal. Spray 80% HCB	W	1/2	6.7	

[a]Liquid. [b]Wettable powder

Table 3. Summary of results from 8 regional seed treatment tests for the simultaneous control of SEED- and SOIL-BORNE common bunt in winter wheat in the Pacific Northwest, 1957.

Treatment	Form	Ounces Per Bushel	Percent Bunt	Statistical Significance
Open Furrow Inoculation				
Check - untreated			63.7	
Panogen 15	L[a]	3/4	39.6	
Captan + HCB 40-40	W[b]	1	9.4	
Chipman 80% HCB	W	1/2	9.3	
Smut Go	W	1	8.9	
Terraclor	W	1	8.2	
Sanocide	W	1	8.1	
No Bunt	W	1	7.9	
RE-3681	L	4 1/2	7.8	
Cal. Spray 80% HCB	W	1/2	7.6	
Anticarie	W	1	6.0	

[a]Liquid [b]Wettable powder

Table 4. Summary of results from 7 regional seed treatment tests for the control of SOIL-BORNE common bunt in winter wheat in the Pacific Northwest, 1957.

Soil-surface inoculation

Treatment	Form	Ounces Per Bushel	Percent Bunt	Statistical Significance
Check - untreated			21.9	a
Panogen 15	L[a]	3/4	12.9	b
Smut Go	W[b]	1	2.8	c
Captan + HCB 40-40	W	1	2.7	c
RE-3681	L	4 1/2	2.2	c
No Bunt	W	1	1.5	c
Sanocide	W	1	1.3	c
Terraclor	W	1	1.3	c
Chipman 80% HCB	W	1/2	1.2	c
Cal. Spray 80% HCB	W	1/2	0.9	c
Anticarie	W	1	0.4	c

[a]Liquid [b]Wettable powder

Table 5. Summary of results from 7 regional seed treatment tests for the simultaneous control of SEED- and SOIL-BORNE common bunt in winter wheat in the Pacific Northwest, 1957.

Soil-surface inoculation

Treatment	Form	Ounces Per Bushel	Percent Bunt	Statistical Significance
Check - untreated			57.7	a
Panogen 15	L[a]	3/4	20.0	b
Terraclor	W[b]	1	7.5	c
No Bunt	W	1	3.6	d
Chipman 80% HCB	W	1/2	3.1	d
Smut Go	W	1	3.0	d
Cal. Spray 80% HCB	W	1/2	2.5	d
RE-3681	L	4 1/2	2.1	d
Captan + HCB 40-40	W	1	1.7	d
Anticarie	W	1	1.6	d
Sanocide	W	1	0.9	d

[a]Liquid [b]Wettable powder

in Table 2. A high incidence of bunt developed in all check rows, averaging 51.4 percent for all locations. The formulations of HCB provided good control in all cases, although they were slightly less effective than in previous tests. However, the differential effectiveness of HCB and mercury was about the same as in all previous tests, far better control being obtained with HCB.

In the tests where inoculated seed was planted in furrows, it is interesting to note that there was a differential similar to the above between the mercury and HCB (Table 3). This indicated that the mercurials controlled the seed-borne phase but failed to control the soil-borne phase, whereas the HCB preparations and Terraclor controlled both phases.

The results of the tests where bunt-free seed was drilled into soil, inoculated only on the surface, are summarized in Table 4. The average of 21.9 percent bunt in the check rows of this test was lower than in the open furrow tests (Table 2). Relatively good control was obtained with all HCB preparations and Terraclor, while the mercury compound again gave poor control. Thus, this method of seeding, which simulates commercial seeding, does not reduce the effectiveness of HCB in controlling soil-borne common bunt[7].

The results of tests using inoculated seed drilled into soil, inoculated only on the surface, are presented in Table 5. In these tests a high incidence of bunt developed in the check rows at all locations[8], the average being 57.7 percent. The HCB formulations gave good control, while Terraclor (PCNB) was somewhat less effective and the mercury preparation was only partially effective. The control with HCB was significantly better than that with mercury, although the mercury was significantly better than the check in this test. This was due to the fact that the mercury controlled the seed-borne phase but failed to control bunt that originated from soil-borne spores, as indicated by the amounts of bunt in the mercury treatments in Tables 4 and 5.

UNITED STATES DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, CROPS RESEARCH DIVISION, AND THE AGRICULTURAL EXPERIMENT STATIONS OF IDAHO, MONTANA, OREGON, UTAH, AND WASHINGTON

[7]Holton, C. S., and L. H. Purdy. 1954. Control of soil-borne common bunt of winter wheat in the Pacific Northwest by seed treatment. Plant Dis. Reptr. 38: 753-754.

[8]Because of wet weather this portion of the test was not planted at Worley, Idaho.

NEW HOST RECORDS FOR DWARF BUNT IN THE PACIFIC NORTHWEST. II.[1]

J. P. Meiners and J. R. Hardison[2]

Seven grass species, infected with the dwarf bunt fungus, Tilletia contraversa Kuehn, in the Pacific Northwest, are here reported as additions to the world list of grass hosts for dwarf bunt (1, 4). The new grass hosts are Agropyron amurense Drob., A. dasystachyum (Hook.) Scribn., A. riparium Scribn. & Smith, Elymus glaucus Buckl., E. triticoides Buckl., Festuca idahoensis Elmer, and Koeleria cristata (L.) Pers. Dwarf bunt was also found on A. repens L. which has not previously been reported as a host of T. contraversa in North America. The first four grass species became infected following inoculation with dwarf bunt spores from wheat at Pullman, Washington. The last four hosts as well as A. dasystachyum were found in or near experimental plantings in northeastern Oregon. Species of Koeleria have not been previously reported as hosts of dwarf bunt.

Symptoms of infected plants were characteristic for dwarf bunt. The infected spikes of Agropyron dasystachyum, A. repens, and E. triticoides were broadened (Figure 1), and the thickened culms were dwarfed to about one-half normal height. Only one infected panicle of K. cristata (Figure 2) was found, and the infected culm was about two-thirds normal height. The numerous infected panicles of F. idahoensis (Figure 2) were borne on culms that varied from severely dwarfed to normal. Some of the affected panicles were only partially smutted.

Six species of Elymus, including E. glaucus and E. triticoides, are now known to be susceptible to dwarf bunt. In 1956, dwarf bunt was reported on E. canadensis L. in Idaho and Oregon and on E. sibiricus L. in the latter State (5). Dwarf bunt on E. aralensis Regel from Turkestan and on E. crinitus Schreb. from Greece was discovered in herbarium specimens by Duran and Fischer (1).

Seed of a number of grass species was sown in a row-type nursery at Pullman, Washington, in October, both in 1955 and 1956. Immediately after the seed was covered, the soil surface was sprinkled with a suspension of dwarf bunt spores taken from wheat near Pullman. Most of these grasses were known from previous experiments to be susceptible to common bunt, Tilletia caries (DC.) Tul. (8), but their reaction to dwarf bunt was not known. The results of these tests show that some of these species are also susceptible to dwarf bunt. Those species in which dwarf bunt was observed for the first time were Elymus glaucus, Agropyron amurense, A. dasystachyum, and A. riparium. A known susceptible species (A. intermedium (Host) Beauv.) was also susceptible in this test. Nearly all species of Agropyron sown in dwarf bunt-infested soil have been found to be susceptible to this disease (4, 5, 7). Notable exceptions were A. smithii Rydb. and A. spicatum (Pursh) Scribn. & Smith.

Infection of Festuca idahoensis (Idaho fescue) adds a third species of this genus to the host range of dwarf bunt. Dwarf bunt was reported on F. rubra L. (red fescue) in 1953 (2), and F. elatior L. (meadow fescue) in 1956 (5).

Two infected spikes of Agropyron repens L. were found in a natural stand of this grass adjacent to a field with a recent history of heavy dwarf bunt infestation in wheat. This is the first record in North America of dwarf bunt on the type host, A. repens, on which Tilletia contraversa was originally described by Kuehn in Europe (6).

Infection was also noted in ordinary tall oatgrass, Arrhenatherum elatius (L.) Presl. This plant, the normal type for this species, has no basal stem swelling and is subject to early and severe seed shattering. The shatterproof Tualatin variety of oatgrass is characterized by moderate swelling of the basal stems, thus approaching tuber oatgrass, A. elatius var. bulbosum (Willd.) Spenner. Tualatin oatgrass infected with dwarf bunt has been seen in varying amounts at locations in Oregon and Idaho every year since the fungus was first reported on this grass in 1952 (3). However, none of the recent infestations in the Tualatin variety has been as severe as the 1952 outbreak in Oregon.

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[1]Cooperative investigations between the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Oregon, Washington, and Idaho Agricultural Experiment Stations. Scientific Paper No. 1665, Washington Agricultural Experiment Stations, Pullman, Washington.

[2]Pathologists, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

FIGURE 1. Healthy (left) and dwarf bunt-infected spikes (right) of Agropyron dasystachyum, Agropyron repens, and Elymus triticoides.

FIGURE 2. Healthy (left) and dwarf bunt-infected panicles (right) of Koeleria cristata and Festuca idahoensis.

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CROPS RESEARCH DIVISION, AGRICULTURAL RESEARCH SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE, AND THE OREGON, WASHINGTON, AND IDAHO AGRICULTURAL EXPERIMENT STATIONS

DISEASES OF SMALL GRAINS OBSERVED IN GEORGIA DURING THE 1956-57 SEASON[1]

Luther L. Farrar and U. R. Gore

The small grain acreage in Georgia usually exceeds 1,000,000 acres. Oats are planted to more than one-half of this acreage, and wheat occupies the greater part of the remainder. Barley and rye usually occupy a very small percentage.

During the 1956-57 season two statewide disease surveys were made to determine the diseases present on small grains. The surveys were made during the first weeks of February and March. In addition, diseases present in the small grain nurseries at Experiment were observed throughout the season.

Abundant rainfall and mild winter temperatures prevailed in most of Georgia throughout the season. These factors were conducive to higher incidence than usual of many diseases, and to larger aphid populations, although frequent cold periods reduced the numbers of aphids. Yellow-leaf of oats (apparently due to an aphid-transmissible virus) was widespread for the first time and probably caused considerable losses.

OATS

Several diseases were observed on this crop, but their occurrence was usually sporadic. Crown rust (Puccinia coronata) was prevalent, with losses ranging from almost nothing to 100 percent. Fifty acres of the Dubois variety in Peach County were completely destroyed. The rust was observed as early as October on the variety Cimmaron at Blairsville (north Georgia) and in September on the variety Victorgrain in middle Georgia. However, subsequent damage was not generally so severe in northern as in southern Georgia.

Victoria blight (Helminthosporium victoriae) was observed in 32 of 47 counties surveyed. Stand reduction was usually light to moderate, but single fields of Victorgrain 48-93 in Hancock and Wayne Counties were completely eliminated. One 25-acre field of Victorgrain 48-93 in Spalding county was also heavily infected with H. victoriae, causing leaf spot with symptoms typical of the leaf spot reported by Atkins[2] but appearing at a much earlier stage than time of head emergence. Culm rot (H. sativum) was observed in Southland oats at Experiment where it caused considerable lodging. Leaf blotch (H. avenae) was widespread and in several locations caused considerable damage. Black stem (H. avenae)[3] was observed at Experiment on Southland, Seminole, and Victorgrain 48-93. Incidence observed on Victorgrain 48-93 was low but apparently Southland and Seminole suffered considerable damage.

Powdery mildew (Erysiphe graminis avenae) was unusually heavy on Redrustproof 14, Arlington, Southland, and Victorgrain 48-93 at Experiment, in clipping plots. Considerable forage loss resulted but apparently grain yield was not affected severely.

Loose smut (Ustilago avenae) was prevalent in many plots of Santa Fe at Experiment. Usually, however, only occasional smutted heads were observed in the field.

Oat mosaic (Marmor terrestre) occurred in all susceptible varieties in the nursery at Experiment, but it was not observed over the State. Red leaf (Barley yellow-dwarf virus)[4] was observed throughout the State. Incidence was usually low, but severe infections were observed at several locations in southern and middle Georgia. Yellow-leaf (from preliminary studies due apparently to an aphid-transmissible virus, although the specific virus, or viruses, is not known) was widespread and apparently caused considerable damage. One field of Victorgrain 48-93 in Peach County was almost 100 percent affected by yellow-leaf. Reduction from the 1956 yield was 50 percent in this field, which had an excellent stand with very little leaf rust or Helminthosporium avenae. Yellow-leaf was observed primarily on Victorgrain 48-93, and to a very limited extent on Southland, Redrustproof 14, Fulgrain, and Arlington.

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OTHER CROPS

WHEAT: Leaf rust (Puccinia rubigo-vera tritici) was widespread and caused considerable damage in middle and southern Georgia. At Blairsville (northern Georgia) incidence was somewhat higher than usual, but damage was not so great as in middle and south Georgia. Powdery mildew (Erysiphe graminis tritici) was prevalent throughout Georgia. Leaf and glume blotch (Septoria tritici and S. nodorum) were observed to a limited extent throughout the State. Loose smut (Ustilago tritici) was observed in Spalding County; however, less than 1 percent of the heads were smutted.

RYE: Leaf rust (Puccinia rubigo-vera secalis) and stem rust (P. graminis secalis) caused a complete loss of 29 acres of Tetra Petkus rye in White County. Powdery mildew (Erysiphe graminis secalis), which is not usually severe in Georgia, caused considerable damage to both forage and grain yields at Experiment this season.

BARLEY: Leaf rust (Puccinia hordei) was widespread with moderate to heavy damage in some areas. Powdery mildew (Erysiphe graminis hordei) was widespread. Spot blotch (Helminthosporium sativum), stripe (H. gramineum), and net blotch (H. teres) were present in the nursery at Experiment and to a limited extent in the field. Scald (Rhynchosporium secalis) was observed in the nursery and in the field. Covered smut (Ustilago hordei) and loose smut (U. nuda) were common but caused little damage.

GEORGIA EXPERIMENT STATION, EXPERIMENT, GEORGIA

SUSCEPTIBILITY OF FIVE SWEET CORN VARIETIES TO PYTHIUM GRAMINICOLA[1]

Donald C. Erwin and James W. Cameron[2]

Summary

Pythium graminicola Subr., obtained from diseased roots of Wisconsin 23 sweet corn grown in southern California, incited a root rot on five varieties of sweet corn in greenhouse experiments. In the field root rot from natural infection occurred primarily on the early-maturing varieties (Luther Hill and Wisconsin 23) when grown in late summer. When grown in artificially infested soil in the greenhouse, root rot occurred on these and also on the midseason Purdue 39A and Purdue 51B, and late Iowa 2000 varieties. Purdue 39A, Purdue 51B and Iowa 2000 appeared to be more tolerant to the disease in the field than the others, but this evidence could not be substantiated consistently by greenhouse tests. A necrotic leaf-streak symptom, which occurs in certain sublines of sweet corn inbred Wisconsin 23, was shown not to be incited by P. graminicola.

For the past several years, a root disease of sweet corn has been noted in breeding plots at Riverside during hot weather in July or August. In commercial plantings of hybrid sweet corn the disease has been seen occasionally, but has not been of great economic importance. The present study shows that Pythium graminicola is responsible for the disease. Other workers have shown that this fungus causes root necrosis of seedling corn, especially at temperatures of 22° to 27° C (2, 3, 4, 5). Differential resistance in seedlings of varieties and inbreds of field corn has been demonstrated by these workers. Very little experimental work has been reported to show the effect of this fungus on older plants. Since some varieties of sweet corn at Riverside appeared to be more seriously affected than others during the latter part of the growing season, a study of the relative susceptibility of five varieties was undertaken.

SYMPTOMS

Indications of the disease were first noted in 1949 on field plants 1 to 2 months of age. Early-flowering varieties, when planted in July or August, were most often affected; however, some injury occurred to other better-adapted varieties planted during the same period. The disease has not been severe in plantings in May and early June.

Leaves of affected plants become rolled and wilted. Young plants (1 month old) die rapidly, while older ones (2 to 3 months old) often remain partially wilted for several days. Severe root rot is associated with the wilt. Roots are brown and initially appear to be water-soaked; later they become necrotic. Rotting sometimes extends into the sub-crown internode but seldom above the crown. Stalk rot has not been seen. The sweet corn inbred Wisconsin 23 seemed particularly susceptible to the disease.

METHODS

Inoculum of Pythium graminicola for greenhouse tests was grown on Difco potato-dextrose agar, fortified with 2 g per liter of Difco yeast extract, in Petri dishes. The amount of inoculum (diced mycelium and agar) varied from test to test. Sterilized inoculum was added to the soil of control pots in early tests, but since no deleterious effects due to the sterile agar and mycelium were noted, this practice was discontinued. The soil mix, consisting of 3 parts granitic sandy loam, 1 part sandy silt, and 1 part peat moss, was sterilized by steam.

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Air temperatures of the greenhouse varied from approximately 20° to 30° C. Weights of above-ground parts of the plants were obtained after drying for 3 days in a forced air oven at 55° C.

Varieties of sweet corn selected for the main comparisons were Wisconsin 23 inbred (W23) and an open-pollinated variety Luther Hill (LH), both early types; inbreds Purdue 39A (P39A) and Purdue 51B (P51B), midseason; and inbred Iowa 2000 (I 2000), slightly later than midseason. Examination of roots in early greenhouse experiments showed that roots of all of the varieties were too severly damaged by Pythium graminicola to differentiate the susceptibility of the five varieties. Data were analyzed statistically by the method of Tukey, as outlined by Snedecor (6, Section 10.6). Average reductions in dry weight due to Pythium root rot are expressed as percentages since the varieties had different growth potentials. The actual reduction in dry weight was obtained by subtracting the average dry weight of plants grown in Pythium-infested soil from the average dry weight of plants grown in non-infested soil. The percentage reduction in dry weight was computed by dividing the actual reduction in dry weight by the weight of plants grown in non-infested soil and multiplying by 100.

EXPERIMENTS AND RESULTS

Pathogenicity Tests

Isolations revealed the presence of two fungi, Pythium graminicola and Fusarium moniliforme. Pathogenicity tests were conducted by artificially infesting each of several 5-inch pots of steam-sterilized soil with ten 1/2-inch squares of agar and mycelium of the fungus to be tested prior to planting both Wisconsin 23 and Golden Cross Bantam varieties. Neither fungus caused pre-emergence or post-emergence seedling disease. After 3 weeks, stunting of plants in Pythium-infested soil was noted, but plants in the Fusarium-infested soil were normal when compared with the checks. In 5 weeks leaves of plants growing in Pythium-infested soil became rolled and wilted. Roots were watersoaked and tan in color. These symptoms resembled those seen in the field. No root rot was seen on the plants grown in the Fusarium-infested or in the non-infested soil. Re-isolation of P. graminicola from rotted roots was successful.

In later greenhouse experiments it was noted that the incidence and symptoms of root disease on the two varieties, Wisconsin 23 and Golden Cross Bantam, was equally severe in both naturally and artificially infested soils.

Reactions of Sweet Corn Varieties to Pythium graminicola

Since W23 had appeared to be the most susceptible of the inbreds observed in the field, experiments were carried out to compare its reaction with those of LH, P39A, P51B, and I 2000. Plants of each variety were grown individually in 1-gallon cans of soil, with four replicates containing non-infested soil and four containing infested soil. In experiment 1 the inoculum consisted of eight 1/2-inch squares of the fungus on PDA per can, placed 2 inches below the soil surface. Plants were grown for 47 days. In experiment 2, four 1/2-inch squares of inoculum were placed in the soil at a depth of 4 inches and the plants were grown for 76 days. Data from two greenhouse experiments are shown in Table 1. In both experiments the average dry weight per plant of each variety was severely reduced in infested soil. The average percentage reduction in weight was greatest in W23 and least in P39A. In the first experiment the difference between W23 and the other four varieties was statistically significant at the 5 percent level, but not in the second. The roots of all varieties were diseased, and the fungus was re-isolated from these roots.

An additional comparison between P39A and W23 was made in the greenhouse in June 1955. Sixteen replications of three plants each were grown in steel tubs approximately 20 inches square by 9 inches deep, with eight replications in infested soil and eight in non-infested soil. Twenty-four 1/2-inch squares of inoculum were placed in the soil of each tub at a depth of 4 inches directly below the seed. Dry weights of tops were recorded after 7 weeks. In the plots infested with Pythium there was a highly significant reduction in dry weights of both inbreds, but the percentage reduction was approximately the same for each of the two inbreds.

In July 1955, W23, P39A, P51B, LH, and I 2000 were further compared in a replicated field test, which included 150 plants of each variety except P51B for which there were only 80 plants. After 64 days wilting and root rot had occurred in 30 percent of the W23 plants,

Table 1. Comparison of the effects of Pythium graminicola on five sweet corn varieties in the greenhouse and in the field.

Variety	Greenhouse experiment 1 Average reduction in dry weight (percent)[a]	Greenhouse experiment 2 Average reduction in dry weight (percent)[b]	Field experiment Plants killed by root rot (percent)
Purdue 39A	76	54	1
Purdue 51B	85	62	0
Iowa 2000	80	57	3
Luther Hill	88	55	8
Wisconsin 23	92	68	30

[a]Average reduction in weight of Wisconsin 23 differed significantly from that of the other four varieties at the 5 percent level.
[b]Average reduction in weight of the five varieties did not differ significantly.

8 percent of LH, 3 percent of I 2000, 1 percent of P39A, and in none of P51B (Table 1). This order of susceptibility agrees with previous field observations but differs from the results obtained in greenhouse tests.

Certain sublines of W23 were subject to a leaf necrosis, the cause of which is still under study. On affected plants small, narrow, pale-green areas appear on the leaf blades of young leaves and spread outward and lengthwise, causing a streak. As the leaves grow older the affected portions shrivel and become necrotic. Seed production is usually reduced, but the plants seldom die. The symptoms appear to differ from those described by Frazier (1) on corn in central California.

To determine whether or not Pythium graminicola was the incitant of the leaf-streak symptom, the affected subline of W23, a normal W23 subline, and P39A which had never shown the disorder, were grown in both Pythium-infested and non-infested soil in a lathhouse for 61 days. Leaf-streaking was observed in 14 out of 16 plants of the susceptible subline of W23 in both infested and non-infested soils. Plants of the normal subline of W23 and plants of P39A showed no streaks when grown in either soil. Thus the leaf streaking is not dependent on P. graminicola for expression. Plants of all three varieties in the infested soil were wilted and stunted and the reduction in dry weights due to Pythium was statistically highly significant. As in past tests the percentage reduction in dry weights of the three varieties did not differ statistically.

DISCUSSION

This study shows that Pythium graminicola is the incitant of a root disease of sweet corn in southern California. The disease has been more injurious to older plants at high temperatures than to seedlings. Typical symptoms of root rot and stunting were reproduced by the fungus in greenhouse trials. Although the W23 and LH varieties were apparently much more susceptible to the disease in the field than were P51, P39A and I 2000, this differential susceptibility could not be demonstrated consistently in artificially infested soil in greenhouse tests. Since severe root infection of all varieties occurred, it was evident that P39A, P51, and I 2000 were not resistant to the fungus under greenhouse conditions. The reasons for the difference in the reactions of the varieties in the field and in the greenhouse are not clear. Environmental conditions may play a determining role in expression of this disease. W23 is an early maturing inbred and is not vigorous at high soil and air temperatures. It may be more susceptible to the disease under high temperatures which occur in the field in late summer at Riverside. It is also probable that more soil-moisture stress is exerted on a corn plant during periods between irrigations in the field than in the greenhouse where plants are watered daily. This may accentuate the wilting symptoms on plants of a variety like W23 with limited potential for root growth.

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SORGHUM SEED-TREATMENT TESTS IN 1957[1]

R. W. Leukel and O. J. Webster[2]

In field tests in 1956, covered kernel smut in Rancher sorgo was completely controlled at three locations[3] by treating the seed with any one of seven mercurials at rates of 2, 3, and 4 ounces per bushel. These excessive rates are not generally recommended for applying these mercurials to sorghum seed, because of resultant seed injury. They were used in these experiments to determine whether seed treatments applied at rates greater than are generally recommended can prevent covered kernel smut in a variety whose seeds have persistent glumes. In these tests, Phygon and Orthocide, two non-mercurials, applied at excessive rates eliminated smut at Clemson, South Carolina, and at Lincoln, Nebraska, but not at Beltsville. Infection in Combine-60 kafir was completely eliminated by all of the treatments applied at the recommended rates.

Table 1. Percent infection by covered kernel smut (Sphacelotheca sorghi) in Combine-60 kafir and Rancher sorgo, grown from smut-inoculated seed, untreated, or treated as shown, and planted in field plots at Beltsville, Maryland, and at Lincoln, Nebraska, 1957.

Seed treatment applied				Average percent infection in -			
				Combine-60 at		Rancher sorgo at	
No.	Fungicide	Form	Oz/Bu.	Beltsville	Lincoln	Beltsville	Lincoln
1	Check	--	--	25.0	16.4	32.1	13.8
2	Arasan 75	Slurry	1.5	0	0.2	18.5	3.7
3	Panoram 75	Slurry	1.5	0.8	0	21.5	4.3
4	Orthocide	Slurry	1.5	0	0	21.8	0.6
5	Phygon	Slurry	1.5	0	0	0	0
6	Spergon	Slurry	1.5	0	0.3	7.2	0
7	Arasan S F M	Slurry	1.5	0.9	0.6	28.7	4.1
8	Delsan A D	Slurry	1.5	3.3	0.2	40.0	1.6
9	Ortho Seed Guard	Slurry	1.5	1.2	0.5	30.4	8.0
10	Panoram D-31	Slurry	1.5	2.0	0.4	23.8	3.8
11	Vancide	Liquid	2.0	2.5	0	19.7	6.1
12	Copper carbonate	Dust	2.0	2.4	1.3	6.7	2.4
13	Untreated	--	--	39.6	6.2	27.3	7.1
14	Agrox	Slurry	0.75	0	0	10.0	1.0
15	Ceresan M	Slurry	0.75	0	0	0	0
16	Velsicol	Slurry	0.75	0	0.2	1.2	0
17	Puraseed	Slurry	0.75	0	0	1.8	0
18	Ceresan 75	Liquid	0.75	0.7	0.6	1.4	0
19	Mema M N	Liquid	0.75	0	0.4	2.3	0.5
20	Metasol M	Liquid	0.75	0.8	0.7	1.6	0.5
21	Panogen 15	Liquid	0.75	0	0.7	0	0
22	Setrete	Liquid	0.75	0	0	8.3	0
23	Velsicol	Liquid	0.75	0.9	0.4	14.5	7.5
24	T. M. F. 142	Liquid	0.75	44.1	15.9	30.4	8.7

[1]Cooperative investigations of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, and the Nebraska Agricultural Experiment Station.

[2]Pathologist and Agronomist respectively, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

[3]R. W. Leukel, O. J. Webster, and R. W. Earhart. Seed-treatment tests on sorghum in 1956. Plant Dis. Reptr. 40: 1071-1072. 1956.

In seed-treatment tests in 1957, eleven samples of smut-infested Rancher seed were treated at the generally recommended rate of 3/4 ounce per bushel, each with one of eleven mercurials. Eleven other samples were treated at the rate of 1.5 ounces per bushel each with one of eleven non-mercurials. Similar samples of Combine-60 kafir were treated with these same materials at the rates mentioned. Germination tests in soil in the greenhouse showed no injury to Rancher or Combine-60 from any of the treatments.

Field plantings were made at Beltsville on June 11, and at Lincoln on May 28 and June 13. At Beltsville the field stands were adversely affected by lack of soil moisture due to a prolonged drought. This reduced somewhat the significance of the data on smut control obtained in October. At Lincoln gophers caused considerable injury and some rows in the first planting had to be replanted. The data on smut control taken at both stations are shown in Table 1.

At Beltsville infection in the Combine-60 checks averaged 32.3 percent. Four of the non-mercurials eliminated smut infection completely in this variety, while the remainder allowed from 0.8 to 3.3 percent. Seven of the mercurials eliminated infection, while three allowed less than 1 percent.

At Lincoln, with an average infection of 11.3 percent in the Combine-60 checks, four non-mercurials and four mercurials eliminated smut, while the rest with one exception allowed from 0.2 to 1.3 percent infection. Number 24 (TMF 142), an experimental material, proved entirely ineffective in smut control.

Infection in Rancher grown from untreated seed averaged 29.7 percent at Beltsville and 10.5 percent at Lincoln. At both stations smut was completely controlled in this glumed variety by Phygon, Ceresan M, and Panogen. At Lincoln, infection was completely eliminated also by Spergon, a non-mercurial, and by five other mercurials.

Phygon, a relatively nonpoisonous non-mercurial, has been consistently effective in the control of covered kernel smut in sorghum in several seasons' tests, even in varieties whose seeds have persistent glumes. It has caused no seed injury, even when applied at excessive rates.

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ASTER YELLOWS DESTRUCTIVE TO FLAX IN THE UPPER MISSISSIPPI VALLEY IN 1957[1]

Richard A. Frederiksen and J. J. Christensen[2]

Although aster yellows has been observed in the Midwest for more than 25 years this is the first time that it has become prevalent and destructive in commercial flax fields in Minnesota. Infection of flax by the aster yellows virus was first described by Severin in 1945[3]. In recent years from a trace to 1 or 2 percent infection has been common in many fields in Minnesota. In 1957 infection varied from a trace to 30 percent, and 20 percent was not uncommon. The disease was widespread throughout the entire State, and in North and South Dakota as well.

The recent outbreak has been attributed partially to the high numbers of the insect vectors which appeared in the flax growing area. Aster yellows virus is transmitted primarily by one insect species, Macrosteles fascifrons, the six-spotted leafhopper. This virus is neither seedborne nor mechanically transmitted.

The commonly recognized symptoms are yellowed plants with numerous adventitious branches, and yellow aborted flowers, each flower containing a rudimentary corolla and a nearly normal calyx. The sepals usually assume an erect position, forming a star-shaped structure (Figures 1 and 2). There is little boll development on severely infected plants or on plants infected early in the growing season. Occasionally a plant may be only partially infected, that is, it may have apparently virus-free branches that may give rise to normal bolls.

FIGURE 1. A flax blossom infected with the aster yellows virus. Note the erect sepals and the rudimentary flower parts. No boll will develop from this flower.

FIGURE 2. The flax flower on the left has been infected by the aster yellows virus, the one on the right is normal. Note position of the sepals on the flower bud in the upper right hand corner. These sepals tightly encase the bud.

Partially infected plants of 30 different varieties were compared with normal plants during the summer of 1956. The average number of bolls produced on normal plants was 52 bolls of 8 seeds each, whereas on partially infected plants production averaged 31 bolls with 5 seeds per boll. This represents a reduction of nearly two-thirds from the seed production of normal plants.

More than 900 varieties and lines in the world collection of flax were tested for reaction to aster yellows virus at Rosemount, Minnesota, during the summer of 1957. Most varieties were found to be susceptible, but a few appeared to be virtually free from infection. Lines with very few or no apparent infections have been selected for further studies.

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[1]Paper No. 953, Miscellaneous Journal Series, Minnesota Agricultural Experiment Station.
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OBSERVATIONS ON CURLY TOP OF FLAX IN TEXAS[1]

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Summary

A disease present in experimental flax tests in Texas the past three seasons and in some commercial fields in 1957 has been identified as curly top. Earlier it was believed the vector was not present but recent studies have shown that the beet leafhopper, the only known vector for the curly top virus, has moved into Central Texas. Marked recurring differences in reaction of varieties and strains has been observed but no variety tested is immune or even highly resistant. Some progress in selecting tolerant strains appears to have been made. Date of sowing and the nature of surrounding flora appear to be important factors in severity of the disease.

INTRODUCTION

Curly top virus disease caused significant reductions in yields of early sown flax in Texas in 1957 and has been a major disease in early sown experimental tests of flax at College Station, Texas during each of the past three season. No reports of the disease in commercial fields were received previous to 1957, but this is not surprising as the flax growing area has experienced severe drought for the past 7 years and disease symptoms could easily have been confused with drought. This drought has been so severe that flax acreage has dropped from 349,000 in 1949 to 17,000 in 1957.

The curly top disease on flax was first reported in 1929 by Severin (5), who inoculated plants with the virus and observed symptoms similar to those on many other plants. Natural occurrence of the disease was reported in California in 1944 by Severin and Houston (6). They also observed that time of seeding of the crop had an important influence on the severity of the disease. Giddings (3) tested varieties and species of flax for their reaction to the disease and found that all commercial varieties which they tested were susceptible but that three ornamental related species were highly resistant.

EXPERIMENTAL AND OBSERVATIONAL DATA

The flax crop in Texas has been unusually free of damaging diseases in previous years. The first commercial flax was grown in 1938. As most of the acreage was of the susceptible Bison variety it was attacked by rust [Melampsora lini] in 1941. Rust resistant varieties were introduced and no further serious losses from rust or other disease have occurred. Pasmo [Mycosphaerella linorum], anthracnose [Colletotrichum lini], and seedling blights have been reported as causing minor damage in a few seasons.

Rather serious seedling losses occurred in the nursery at College Station in the fall of 1953. Stewart and Whitehead (7) isolated Fusarium spp., Pythium spp., and Rhizoctonia solani Kuehn from affected plants. The marked reduction in stand was thought to be due to invasion by these fungi, but later experience suggests that curly top may have predisposed the plants to attack by these common soil organisms.

Sprinkler irrigation facilities have been available at College Station since 1953, and it has been the practice to irrigate if necessary to establish stands early. Resistance to cold weather in the winter-type varieties and strains is greatly dependent on establishment of a good root system and development of a rosette of leaves. Flax sown in October of 1954 began to turn yellow and develop symptoms of what is now known to be curly top. The disease pro-

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[1]A report of cooperative research of the Texas Agricultural Experiment Station and the Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

[2]Respectively Research Agronomist in charge of small grain research, Texas Agricultural Experiment Station and Crops Research Division, Agricultural Research Service, United States Department of Agriculture; Research Pathologist and Research Agronomist, Crops Research Division, Agricultural Research Service, United States Department of Agriculture.

gressed slowly during the winter months, with some varieties more seriously damaged than others. Severe spring drought and two severe spring freezes caused a near failure of the 1955 crop. Yields were less than 5 bushels per acre. Nematodes were suggested as a possible cause of the apparent diseased condition. Although one sampling of the soil examined for nematodes by a nematologist showed the presence of two parasitic species, further sampling in the 1955 and 1956 seasons have ruled this out as a cause of the disease in question.

A behavior pattern similar to that observed in 1954 has occurred each season since. Plants turn bronze, then yellow with leaves curled along the stem in the seedling stage in December. Many plants die early and others continue to die throughout the winter. Plants that were not killed were reduced in size and the production of tillers was reduced. The terminal leaves and flower parts were discolored, crinkled and distorted so that few seed were set. Some varieties and strains appear more tolerant than others, as manifested by less killing and more spring recovery in spite of apparent infection.

Damage to the College Station Nursery was severe during the past three seasons, and but for supplemental irrigation yields probably would have been low. Nurseries grown without irrigation at Temple and Beeville were so badly damaged that the one at Temple was abandoned in 1956 and the one at Beeville made very low yields. Samples of diseased plants were collected at College Station, at Beeville, and from some commercial fields in 1957, and sent to Dr. Byron Houston at Davis, California where the condition was positively identified as curly top. In 1957 the nurseries at Temple and Lockhart, although seeded in November, emerged in February and under these conditions there was very little damage by the disease.

Varieties

Observations on varietal reaction have been made only under field conditions and differences recorded may be due to preferences of the vector, to variations in insect populations, to escape or tolerance. Certain varietal differences are fairly consistent, as evidenced by seedling losses, recovery, and seed yields. No variety tested appears immune. The observed percentage of infected plants for a selected group of strains is given in Table 1.

Table 1. Reaction of a selected group of varieties of flax to curly top under Texas conditions, 1955-57.

	Percent infected plants				
Variety	College 1955	College 1956	Temple 1956	College 1957	Average
Newturk	20	50	73	73	54.0
Viking	18	30	63	70	45.1
Deoro	15	16	43	50	31.0
Rio	23	10	53	38	30.9
Linda	20	9	38	53	30.0
B5128	24	6	43	33	26.5
Redwood	18	6	35	43	25.4
Caldwell	7	7	48	33	23.6
Sel. 274	12	9	38	20	19.6

Viking, Newturk, and several experimental strains have consistently been seriously affected, producing much reduced yields. Rio and B5128 show symptoms of the disease but apparently are tolerant as the yields have not been greatly reduced. The degree of thinning characteristic of Viking, Deoro, and Rio is shown in Figure 1.

The percentage infection and yields in 1956 and the progressive devlopment of the disease and yield in 1957 for several varieties are shown in Table 2.

Table 2. Percentage curly top infection and yields in 1956 and 1957 for selected flax varieties at College Station, Texas

	1956		1957			
	Percent infection	Grain yield bushel	Percent infection Jan. 7	Feb. 11	Mar. 27	Grain yield bushel
Sel. 274*	9	20.3	15	21	20	23.9
B5128	6	26.6	18	26	33	20.0
Caldwell	7	26.7	15	21	33	19.4
Rio	10	22.1	28	24	43	13.4
Redwood	6	21.4	43	25	43	11.6
Linda	9	21.3	38	28	53	10.5
Newturk	50	9.9	25	31	73	9.8
Viking	30	14.9	40	53	73	9.0

*Turkey x Roman Winter.

FIGURE 1. Nursery plots of Rio, Deoro and Viking flax at College Station, Texas, May 1957, showing relative thinning by curly top.

FIGURE 2. Reaction to curly top of Strain 10 and reselections of it at College Station, Texas, 1957.

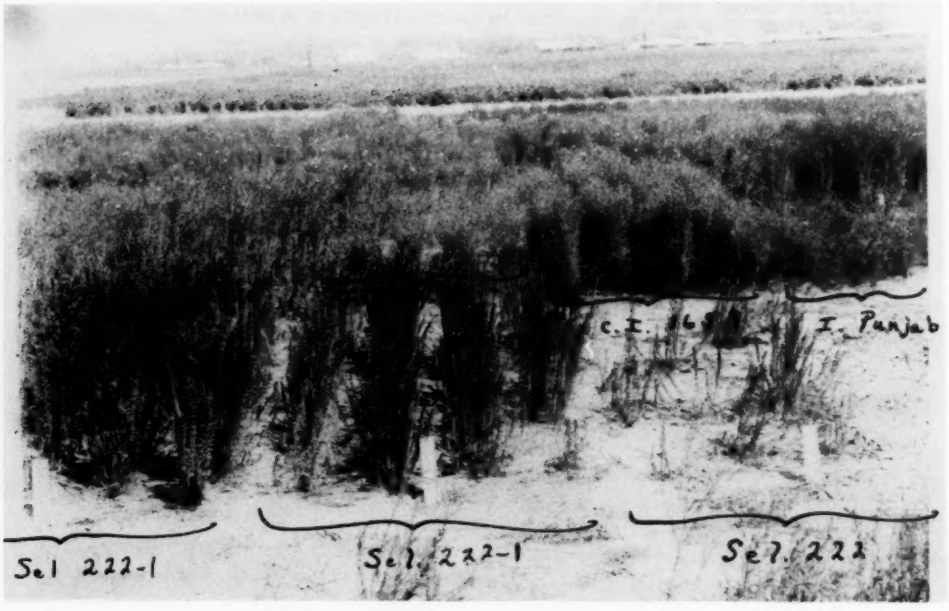

FIGURE 3. Reaction of Strain 222 and reselections from it at College Station, Texas, 1957.

Selecting for Tolerance to Curly Top

Three experimental strains of winter type flax were sown in preliminary increase plots in 1955. These were Roman Winter x Argentina Pale Blue, Selection 252, later named Caldwell; and Turkey x Roman Winter Selections 10 and 222. They were separated from each other by distances of approximately 1/4 mile. The first strain showed only traces of curly top, while the second was attacked but appeared to be heterozygous for reaction. The third was almost completely destroyed. In replicated yield tests nearby these strains showed 10, 12, and 84 percent infection respectively. Seed from the first strain was saved for further increase. Two hundred plant selections were saved from each of the other strains and sown in plant rows in 1956. The reselections from Strain 10 showed varying degrees of tolerance, with some appearing quite tolerant. Ten reselections were saved for further testing. The reselections from strain 222 were much poorer in tolerance and only two were considered worth saving.

The behavior of these reselections in 1957 was interesting as shown in Figure 2. Reselections from strain 10 again ranged from highly susceptible to highly tolerant. Three were more susceptible than the parent strain, four appeared more tolerant and might be classed as moderately susceptible to the disease, while three were highly tolerant, one yielding at the rate of 22.7 bushels per acre in the single 4-row nursery plot whereas the susceptible lines were not worth harvesting. The further behavior of these strains will be watched with interest.

Strain 222 was again killed out in 1957 but the reselections were slightly better, as shown in Figure 3. The reaction of Bolley, C. I. 1478, and C. I. 1658 is shown in the background of Figure 3. These strains were not damaged by curly top but Bolley was so early that it was damaged by frosts.

Selection 252 was named Caldwell and increased in 1956 and 1957. It was damaged some in 1956, but when moved to a commercial field and grown under irrigation at George West, Texas was completely killed out by the disease. It was sown very early and surrounded by brush and range land. As a result of these experiences we are not sure of the status of its resistance to curly top.

Date of Seeding

Severin and Houston (6), as well as Giddings (3), observed that early seeded flax was damaged more severely than late seeded flax. This was attributed to the fact that the beet leafhopper was more active and numerous in the early season. It has not been possible, because of moisture limitations, to conduct date of seeding tests under Texas conditions. However, observations in both experimental and field plantings indicate clearly that this factor is of major importance as has been shown in other States.

Experimental nursery tests at College Station were seeded early in each of the past three seasons and have experienced severe damage. The Temple nursery was damaged in 1956 when it emerged early, but not in 1957 when it emerged in February. Commercial fields seeded in December in the Kenedy-Karnes City area were damaged in 1957 whereas February-seeded fields showed only slight damage. One farmer reported that his early flax yielded 3 bushels per acre while his February-sown flax yielded 7 bushels.

The loss of the Caldwell variety can probably also be explained by planting dates and other circumstances. This new variety appeared the most tolerant and produced the best yields in nursery tests in 1954, 1955 and 1956. However, when moved to a field planting in 1955 it was damaged and in 1957 when seeded early in an area where there was no other green vegetation, it was destroyed by the virus. It is quite possible that there is preferential feeding by the leafhopper when several varieties are available, as in a variety test. On the other hand, if only one variety is available even a tolerant variety and less attractive variety may be attacked vigorously.

Beet Leafhopper Populations

The populations, overwintering, and spread of the beet leafhopper, only known vector of the curly top virus, have been studied in the Southwest in recent years because of the relationship to sugar beet and vegetable growing. The Winter Garden area, a winter vegetable growing area, lies about 100 miles west of the principal flax-growing area of Texas. Curly top was reported in that area in 1939 and in recent years has occurred at a number of locations in the western half of Texas. According to Rommey (4) the spring breeding areas of the beet

leafhopper were confined to southern New Mexico and southwestern Texas. A severe drought, with less than one-half normal rainfall, has prevailed in the flax area since 1951. Studies by Douglass (1) and by Douglass, Peay and Cowger (2) in 1954 showed that the beet leafhopper had moved eastward and now is found in the entire western half of Texas. Curly top has been severe on vegetable crops in several recent years. It is believed that this recent eastward movement has been responsible for the present outbreak of curly top in flax. Whether or not the disease will decrease in importance as seasons are more favorable for crop growth remains to be seen.

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TEXAS AGRICULTURAL EXPERIMENT STATION, AND UNITED STATES DEPARTMENT OF AGRICULTURE, COOPERATING

ROSETTE DISEASE OF SUGAR BEET

C. W. Bennett and James E. Duffus[1]

Summary

A disorder of sugar beet, characterized by dwarfing and rosetting of tops of affected plants, has been observed annually in sugar beet fields in California over a period of several years. The disease causes severe damage to infected plants but is of little economic importance due to low incidence of occurrence. Evidence indicates that the disease is caused by a virus that is readily transmissible by graft. The causal virus was transmitted to a low percentage of inoculated plants by means of Cuscuta campestris Yuncker but no transmission was obtained with C. californica Choisy or with C. subinclusa Dur. & Hilg. It was not transmitted by juice inoculation. Also, no transmission was obtained with the green peach aphid (Myzus persicae (Sulz.)), the black bean aphid (Aphis rumicis L.), the potato aphid (Macrosiphum solanifolii (Ashm.), the beet leafhopper (Circulifer tenellus (Baker)), or with the aster leafhopper (Macrosteles divisus (Uhl.)). The disease has been recognized only on sugar beet.

INTRODUCTION

In September 1955, several sugar-beet plants were found in experimental plots at Riverside, California, that showed strap-like central leaves surrounded by leaves that were normal. Beet plants of this type have been noted in sugar beet fields in California in previous years and attributed to genetic variations in the varieties involved. The normal early development of the plants in the experimental plots at Riverside, followed by rosetting of the top, indicated a transmissible agent as the cause of the injury. Two of the affected plants were taken to the U. S. Agricultural Research Station at Salinas, California, for further tests. Results of studies of these and other plants are presented in this report. Because of the type of symptoms produced and the methods by which the disease is transmitted, the causal agent is presumed to be a virus. Following the system of naming plant virus diseases adopted by Wiltshire (2) in the Review of Applied Mycology, the disease has been called "Sugar Beet Rosette".

HOST RANGE AND ECONOMIC IMPORTANCE

Thus far, rosette has been found only on sugar beet, but, since there is no evidence that the causal agent spreads from one beet plant to another in the field, it seems probable that other plants exist and that the virus is transmitted from these plants to sugar beet. The full range of the virus can be determined only after more effective methods for experimental transmission are available.

Beet plants showing characteristic symptoms of rosette have been found in beet fields throughout central and southern California and it seems probable that the disease may have a wide distribution in western United States. In all fields in which diseased plants have been found incidence of occurrence was very low, probably not more than a few plants per acre. Because of this low incidence of infection the disease has been of little economic importance. Diseased plants are greatly reduced in size, however, and widespread infection would undoubtedly result in heavy losses.

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SYMPTOMS

In the field, plants may show evidence of becoming infected over a period extending from May to August. Plants first show abnormalities in the very young leaves followed by the production of the rosette stage of the disease. After the older normal leaves die as a result of aging, the tops of the plants are reduced to clusters of terminal and axillary shoots with strap-like leaves. Plants make very little growth after symptoms appear.

FIGURE 1. Sugar-beet leaves showing reduced size of leaf blade and swelling of the veins of the under side of the leaf produced by sugar-beet rosette virus. About 3/4 natural size.

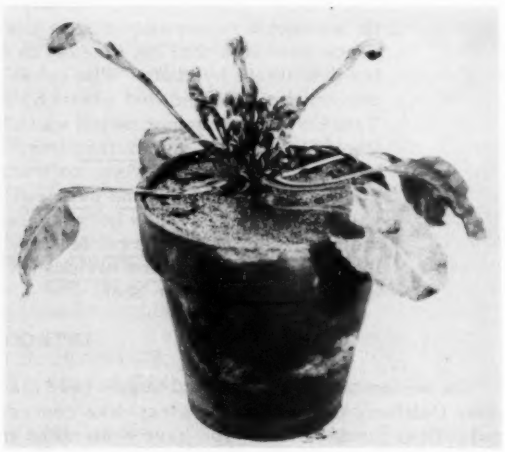

FIGURE 2. Sugar-beet plant showing typical symptoms of sugar-beet rosette. Plant inoculated by means of Cuscuta campestris.

First symptoms of rosette under greenhouse conditions consist of chlorosis and twisting of the very young leaves. As growth continues the blades of the leaves are reduced in size and the first leaves that show symptoms may be dwarfed more on one side than on the other. The midrib may have an abrupt downward bend about one-third of the distance from the leaf tip. Some of the veins show distinct swelling on the under side of the leaf as shown in Figure 1. In some instances, this resembles vein swelling produced by certain mild strains of the curly top virus. New leaves continue to be chlorotic in the early stages of growth. As leaves mature, the petioles are more or less normal but blades are short, narrow, wavy, or otherwise irregular along the margins, and curled downward at the edges. Usually the tip portion of the leaf is cupped and rolled downward and backward, but sometimes the tip is necrotic and the blade more or less spatulate. Soon after first symptoms appear, axillary buds begin to grow and produce shoots with small strap-like leaves. A plant in the early rosette stage is shown in Figure 2.

In the earlier stages in the progress of the disease, drops of colorless liquid may appear on the larger veins of the leaf blades and on the petioles. This liquid appears to be derived from the phloem. It soon oxidizes to a dark color and often supports a fungous growth that may cause local discoloration of blades and petioles. This type of exudate is similar to that seen often on plants with curly top.

TRANSMISSION TESTS

Tests with Juice from Diseased Plants: Extensive attempts were made to transmit the causal virus by means of juice from infected plants. Inoculations were made with juice, immediately after extraction, by rubbing the inoculum over the surface of leaves dusted with carborundum. Sugar beet and some 20 other species of plants belonging to the family Chenopodiaceae were inoculated, in addition to a number of species of plants belonging to other families, but no evidence of infection was obtained.

Transmission by Tissue Union: Roots of diseased plants from Riverside and from the Salinas Valley were used as sources of inoculum in transmission tests involving graftage. In some tests, plugs of tissue from the roots of diseased plants were inserted into holes made with a cork borer in roots of healthy plants. In other tests, slices of tissue were inserted into slits in the crowns of healthy beets. Sixty-two plants were inoculated and 27 of the inoculated plants showed distinct symptoms of the disease. Infection was obtained in all instances in which the tissue used as inoculum remained alive for an extended period and infection was obtained in a few instances in which the infected tissue died after 3 or 4 weeks. A definite union of healthy and diseased tissue appears to be required for infection to occur.

In one test of 20 plants, in which the root serving as the source of inoculum had both yellows and rosette, all of the diseased pieces inserted into the healthy roots died in less than 35 days. No infection with rosette virus was obtained in this test but three of the inoculated plants developed yellows. The yellows virus is known to occur in parenchyma tissue of the beet plants, so it seems probable that a parenchymatous union between diseased and healthy tissue may be sufficient for transmission of yellows virus, whereas the rosette virus may be more closely associated with the phloem and may require a vascular union for its movement from diseased to healthy parts.

Transmission by means of Dodder: Cuscuta californica Choisy, C. campestris Yuncker, and C. subinclusa Dur. & Hilg. were used in tests to determine whether the sugar beet rosette virus is transmitted by means of dodder. Each species of dodder was established on diseased plants. Stems were trained to healthy sugar beet plants and after about 7 days the stems connecting diseased and healthy plants were broken. Inoculated plants were watched for appearance of symptoms of disease.

No infection was obtained with C. californica or C. subinclusa; however, three of 41 plants inoculated by means of C. campestris showed typical symptoms of rosette. The time from inoculation to appearance of symptoms on these plants was 21, 34, and 38 days, respectively. These results show that the rosette virus is transmissible by dodder, but they indicate that dodder is a very inefficient agent of transmission.

After transmission of the rosette virus to sugar beet was obtained by means of Cuscuta campestris, further inoculations were made from sugar beet to Chenopodium capitatum (L.) Asch., C. album L., C. amaranticolor Coste & Reyn., Turkish tobacco, and spinach by means of this species of dodder in an attempt to find other plants susceptible to the rosette virus. No infection was obtained in these tests.

Tests with Insects: The low incidence of natural infection of sugar beet with the rosette virus suggests that the vector is either very inefficient in transmission of the virus or feeds on sugar beet only rarely. Since the disease has some superficial resemblance to curly top, the beet leafhopper (Circulifer tenellus (Baker)) was tested for ability to transmit the causal virus. However, repeated tests with large numbers of leafhoppers failed to indicate that this insect is able to transmit the virus. The aster leafhopper (Microsteles divisus (Uhl.)) and two unidentified leafhoppers found on sugar beet were given limited tests but no transmission was obtained. Tests with large numbers of green peach aphids (Myzus persicae (Sulz.)), the black bean aphid (Aphis rumicis L.), and the potato aphid (Macrosiphum solanifolii Ashm.), gave no infection. It seems probable, therefore, that none of the insects that commonly feed on sugar beet is able to transmit the rosette virus.

POSSIBLE RELATIONSHIPS OF THE ROSETTE VIRUS

Thus far, there is no evidence that the sugar-beet rosette virus is related to any virus described on sugar beet and it seems probable that sugar beet is not a species that would ensure perpetuation of the virus. In all fields where rosette has been observed, the diseased plants were scattered more or less at random. There has been no evidence of spread of the virus from diseased to healthy beet plants. It seems probable, therefore, that the virus is carried into beet fields from outside sources where it persists from year to year.

Beet rosette appears to belong to a group of diseases caused by viruses that usually retain activity for prolonged periods in their insect vectors. Some of these vectors carry viruses long distances. It might be, therefore, that sources of virus for the small amount of infection observed may not necessarily be located in the immediate vicinity of the beet fields.

On the basis of symptoms, it seems probable that the rosette virus is not closely related to the virus of potato witches'-broom as described on sugar beet by Kunkel (1). Failure of the aster leafhopper (Macrosteles divisus) to transmit the virus indicates that it is not related to the aster yellows virus. Further comparisons with other viruses causing diseases of this general type are needed before definite conclusions may be reached as to whether the sugar-beet rosette virus is new or is a virus already known on some host plant other than sugar beet.

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VIRUS-FREE HYDRANGEAS FROM TIP CUTTINGS OF HEAT-TREATED RINGSPOT-AFFECTED STOCK PLANTS

Philip Brierley[1]

On June 20, 1956, plants of Hydrangea macrophylla (Thunb.) DC. variety Charm infected with hydrangea ringspot virus (1, 2, 3) were placed in a greenhouse compartment held at 35° C day and night. Short tip cuttings from these plants were rooted after 4, 12, 15, and 19 weeks' exposures of the parent plants to heat. After these cuttings were well established and growing actively, they were indexed by juice inoculation to Gomphrena globosa L. Repeated index trials showed none of 12 cuttings free of ringspot virus after 4 weeks' exposure; 6 of 9 cuttings proved healthy after 12 weeks', 6 of 9 after 15 weeks', and 6 of 11 after 19 weeks' exposure.

On January 24, 1957, plants of the varieties Charm, Engel's White, Merveille, Monte Forte Perle, Sainte Speer and Strafford, all affected with hydrangea ringspot, were placed at 35° C. Tip cuttings from these were rooted after 9 and 14 weeks' exposure. The resulting plants were permitted to grow until October, when greenhouse temperatures become favorable for the Gomphrena test. By this time the plants developed from the tip cuttings were large, and ample time had elapsed for traces of virus escaping the heat treatment to increase to detectable titer. No healthy plants were found among 17, representing 4 varieties, tested after 9 weeks at 35° C. Of those heated for 14 weeks, 5 of 21 Charm, 1 of 3 Engel's White, 1 of 5 Merveille, 2 of 7 Monte Forte Perle, 1 of 2 Sainte Speer, and 0 of 8 Strafford proved virus-free.

Whenever the heat-treated stock plants have been tested they have yielded the ringspot virus. Thus, there is no evidence that the virus is inactivated throughout the plant by heating. Shoot tips sometimes grow free from virus under conditions unfavorable for virus increase, but not all tip cuttings are virus-free after the longest heat treatments tested. Hydrangeas are unfavorably affected by heating; the terminal shoots frequently die back, so that no vigorous tip cuttings are available. Nevertheless, it appears to be feasible to reclaim virus-free material from all the current commercial varieties of hydrangea, if there is a demand for such stock.

The high degree of tolerance to hydrangea ringspot virus in many hydrangea varieties permits forcers to "live with this virus". Comparative forcing trials of the relatively new varieties Reve Rose, Rose Supreme, Sainte Claire, Sainte Therese and Todi by N. W. Stuart revealed no difference in performance of healthy and ringspot-infected plants. Our heat-treated stocks of other varieties will permit evaluation of the performance of healthy and diseased stocks of these varieties.

It may be feasible to reclaim healthy stock from the garden variety Blue Veil, which carries cucumber mosic virus. Thus far we have had no success in reclaiming healthy shoots from heat-treated Strafford carrying the viruses of tomato ringspot (1) and hydrangea ringspot. These doubly infected plants are weak and more subject to heat damage than are healthy hydrangeas.

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OCCURRENCE OF MALVA YELLOW VEIN MOSAIC IN CALIFORNIA

A. S. Costa[1] and James E. Duffus[2]

Summary

An apparently unrecorded but widespread virus disease, inciting a very striking vein mosaic of Malva weeds, has been found in California. The virus has been mechanically transmitted to Malva parviflora L., M. rotundifolia L., M. sylvestris L., and Lavatera assurgentiflora Kell. The green peach aphid (Myzus persicae Sulz.) is a vector of the virus. The disease is probably identical with one reported affecting Malva plants in Europe.

INTRODUCTION

Species of the genus Malva have become naturalized in California (6) and represent some of the most common weeds in or near the cultivated fields in the Salinas Valley. Weeds of this genus are known to be hosts of many viruses that occur in this area, such as those that induce aster yellows (4), spotted wilt (7, pp. 594-599), cucumber mosaic (7, pp. 668-674), sectorial yellows (2), lettuce mosaic (3), and sugar beet curly top (8). In the course of this study beet mosaic virus was also shown to be capable of infecting a member of this genus, M. parviflora.

An apparently unrecorded but widespread virus disease of Malva weeds in the Salinas Valley causes a very striking vein mosaic in the leaves. This symptom led the writers to name the disease "malva yellow vein mosaic." So far, no economic importance is attributed to malva yellow vein mosaic and no connection has been established between its presence and any disease of cultivated plants in the areas where it occurs.

HOST RANGE

A thorough study of the host range of the virus inciting malva yellow vein mosaic has not been made. Preliminary tests were carried out with inoculum obtained from greenhouse-infected Malva parviflora L. plants that had been inoculated originally with yellow vein mosaic virus from field Malva plants. Mechanical inoculations from that source induced symptoms on M. rotundifolia L., M. sylvestris L., and Lavatera assurgentiflora Kell. Tests to recover the yellow vein mosaic virus from these species by inoculating plants of M. parviflora were successful in all cases.

Comparable inocluations failed to induce symptoms on beet (Beta vulgaris L.), spinach (Spinacia oleracea L.), cotton (Gossypium hirsutum L.), tobacco (Nicotiana tabacum L.), okra (Hibiscus esculentus L.), hollyhock (Althaea rosea (L.) Cav.), and tomato (Lycopersicon esculentum Mill.)

Lavatera assurgentiflora is a member of the Malvaceae family commonly used in certain areas of the Salinas Valley as a windbreak (Fig. 1). Plants in these windbreaks are practically all infected with the virus of malva yellow vein mosaic.

SYMPTOMS

Affected Malva parviflora plants show a very striking yellow mosaic mostly along the main and secondary veins of the leaves (Fig. 2). The interveinal areas may also show yellowing, but the extent of this invasion is generally not great and the symptoms are mostly restricted to the areas immediately adjacent to the veins. The symptoms shown by M. rotundifolia, M. sylvestris, and Lavatera assurgentiflora plants infected by the yellow vein mosaic virus are of the same general type as those described for M. parviflora.

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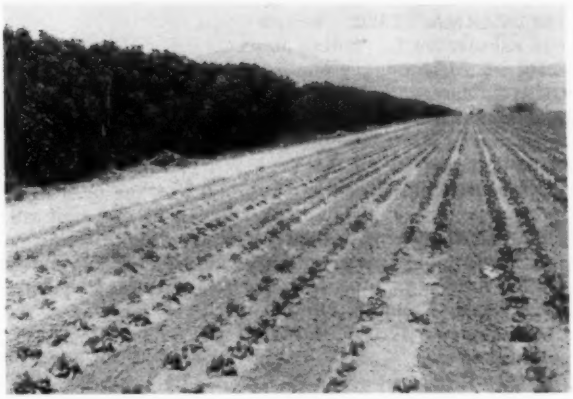

FIGURE 1. Windbreak of Lavatera assurgentiflora in a vegetable ranch in the Salinas Valley.

FIGURE 2. Leaf of Malva parviflora showing yellow vein mosaic symptoms.

Malva parviflora plants affected by green forms of mosaic are also commonly found in the same areas where the yellow vein mosaic occurs, but it has not been established whether the yellow vein mosaic and the green mosaic are caused by variants of the same virus as in Europe (5) or by distinct viruses.

TRANSMISSION

The malva yellow vein mosaic virus is transmissible mechanically by routine methods that include the use of an abrasive. The green peach aphid (Myzus persicae Sulz.) is a vector of the virus. In three tests in which 15 seedlings of Malva parviflora were inoculated by means of ten viruliferous aphids per plant, 14 became diseased. In another test, viruliferous aphids that were fed on healthy M. parviflora test plants for 18 hours transmitted the virus to six out of ten plants. However, the aphids failed to transmit the virus to any of ten plants to which they were subsequently transferred. This is an indication that the relationship of the virus to this vector is of the non-persistent type.

The fact that Malva plants infected by the yellow vein mosaic virus are commonly found in the Salinas Valley indicates that the disease is well established in the area and might be of importance to any susceptible crops. Since windbreaks of Lavatera assurgentiflora are generally affected by the disease, this perennial constitutes an extensive virus reservoir. Recovery of the yellow vein mosaic virus from L. assurgentiflora growing in windbreaks was readily accomplished by transferring green peach aphids from this plant to M. parviflora test plants. Many seedlings of this species growing in the neighborhood of the windbreaks were infected by the virus, and its incidence on Malva seedlings was also high in the proximity of this virus source.

The observation concerning L. assurgentiflora emphasizes the possibility that windbreaks, especially in case of perennials, may serve as reservoirs of viruses that could affect crops planted in their proximity.

YELLOW VEIN MOSAIC AND OTHER DISEASES OF MALVA

A comparison of malva yellow vein mosaic with other diseases reported in the literature indicates that it is probably identical to a disease reported affecting Malva plants in Germany and Russia (5). Failure in attempts to infect hollyhock with yellow vein mosaic indicates that this virus is different from hollyhock mosaic virus as found in England (9), although the latter causes similar symptoms on Malva. The malva yellow vein mosaic virus can be easily distinguished from yellow vein mosaic virus of okra (1) by the fact that the former is an aphid-transmitted virus, and is also mechanically transmissible.

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STRAWBERRY VIRUS TRANSMISSION BY INSERT GRAFT

Paul S. Jorgensen

A simplified graft technique suggested by the leaf graft method described by Bringhurst and Voth[1] has been successfully used to transmit strawberry viruses. This technique requires less digital dexterity and can be accomplished more quickly.

Commercial strawberry varieties are generally indexed by graft to one or more of the several varieties of Fragaria vesca in order to determine either the presence or kind of virus. The Alpine variety of F. vesca has most generally been used as the indicator plant in our tests because of its sensitivity to virus. Also, it is readily reproduced from seed.

Briefly, this method of grafting consists of taking small boatshaped pieces of tissue from the petiole of the plant to be indexed (donor plant) and inserting these pieces in slits cut in the petioles of the indicator plant.

FIGURE 1. Showing insert pieces being cut from donor petiole.

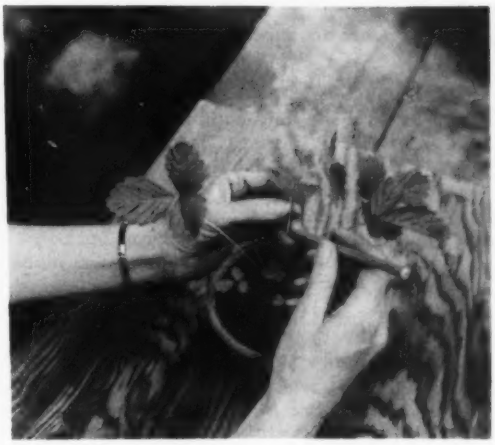

FIGURE 2. Showing slit made in petiole of indicator plant prior to insertion of tissue from donor plant.

To accomplish the graft a relatively young petiole, usually one that has not reached full length, is taken from the donor plant. A section of razor blade held in an "Exacto" holder is used to remove one-third the thickness of the petiole for a length of an inch or more. This cut along the side of the petiole is made to expose the centrally located large vascular bundle. Successive shallow ◡-shaped cuts are then made about 3/16 to 1/4 inch long and 1/16 inch thick so as to include part of the exposed vascular bundle (Fig. 1). After each piece of tissue is cut from the donor it is transferred to a previously prepared slit that extends completely through the petiole of the indicator plant. This slit is made along the median line and long enough to accommodate the insert easily (Fig. 2). After the insert is in place and oriented in a manner similar to that which it occupied in the petiole of the donor plant, the insert is sealed in tightly with "Scotch" tape. This is done with a 1-inch length of 3/4-inch wide tape, placed around the petiole and over the insert in such a manner that the two free ends meet at the side of the petiole. The ends are pinched together tightly to hold the two sides of the slit firmly against the insert. During the process of preparing the inserts and petiole, the cut surfaces are kept wet by dipping the razor blade section in water occasionally.

An insert usually is placed in two separate petioles of the Alpine indicator. The two

[1] Bringhurst, R. S., and Victor Voth. 1956. Strawberry virus transmission by grafting excised leaves. Plant Dis. Reptr. 40: 596-600.

youngest petioles that are large enough to work on conveniently are used. One insert is usually placed in the basal portion of the younger petiole, the other farther out on the older petiole, in order to place the inserts in tissue of medium maturity. Sometimes two inserts are placed in separate slits in the same petiole, making a total of four inserts per plant where it is desired to show or to determine the resultant effect of viruses from two sources.

After grafting, the indicators need no more than ordinary greenhouse care.

When two inserts are used per indicator, virus transmission is usually better than 90 percent.

Originally "Sealtex Latex Tape" was used to cover the graft, which was in turn covered with cellophane tape. This was found later to be unnecessary when care was taken in applying the cellophane tape. The use of the transparent tape alone makes it possible to observe any changes in color of the inserts, although the retention of the green color does not necessarily indicate that a successful union has taken place. Transmission often takes place even though the inserts may turn brown after a period of 2 or 3 weeks, and occasionally there is no transmission even though the insert may remain green for 4 or more weeks.

Some viruses that have successfully been transmitted by this method are: 1) the yellow edge component, 2) a virus tentatively identified as mottle, 3) an undescribed virus tentatively named necrotic shock, and 4) the complete xanthosis complex from commercial production plantings.

As in the method described by Bringhurst and Voth, material for indexing may be collected in the field and carried in polyethlene bags or stored under refrigeration.

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SWEET ORANGE BARK PITTING, AN UNRELIABLE SYMPTOM OF TRISTEZA INFECTION

Farid Nour-Eldin[1] and J. F. L. Childs[2]

INTRODUCTION

Tristeza is one of the more destructive virus diseases affecting citrus trees. The degree of injury can be severe or negligible, depending on the species or top-rootstock combination of the infected tree and on the strain of tristeza virus present. Thus, it becomes important that any symptoms of tristeza infection be recognized and correctly interpreted. The literature on tristeza symptoms is extensive, but only a few of the more pertinent papers are considered here.

For this paper it is sufficient to point out the principal symptoms that have been helpful in diagnosing tristeza. They are as follows: (a) Sieve-tube necrosis as set forth in Schneider's anatomical work (10, 11, 12); (b) stem pitting (5, 6); and (c) bark pitting (1, 4, 12). The term bark pitting as used here is synonymous with the terms inverse xyloporosis, pin points, pin holing, and honeycombing of various authors.

"Inverse xyloporosis" and "pin points" are terms apparently first used by Reichert et al. (8) in reference to Shamouti sweet orange (Citrus sinensis) trees budded on sweet lime (C. aurantifolia) rootstocks and affected with xyloporosis. These authors also observed slight to moderate bark pitting on the following rootstocks: Rough lemon (C. limon), trifoliate orange (Poncirus trifoliata), and Syrian sweet orange, all with Shamouti sweet orange tops. "Pin holing" was reported by Schneider (11, 13) on declining sour lemon (C. limon) trees growing on sour orange (C. aurantium) rootstock. Cohen and Knorr (4) described honeycombing of sour orange rootstock as a symptom of tristeza infection in Florida, but they pointed out that this symptom in other citrus species does not necessarily indicate tristeza infection.

OBSERVATIONS AND EXPERIMENTS

During a survey of citrus diseases in Egypt (2, 3) in 1955, bark pitting was observed on some sweet oranges grown on sour orange and on sweet lime rootstocks.

Two baladi[3] sweet orange trees growing on sour orange rootstock at Tel El Kebir were severely stunted and in declining condition, but both are still alive at this time. Bark patches taken across the bud union line from both trees exhibited bark pitting on the cambial face and slight phloem discoloration on the sweet orange portion (Fig. 1) above the bud union. No abnormalities were observed on the cambial face of the wood or the bark of the sour orange rootstock. Because of the bark pitting these trees were suspected of tristeza infection.

Bark patches from both trees were fixed in F. A. A. solution # 2 (7) and sent to H. Schneider at Riverside, California, for examination. After studying the bark specimens he reported that there was insufficient evidence to support a positive diagnosis of tristeza infection.

In May 1955 buds from these two trees were inserted into four West Indian lime (C. aurantifolia) seedlings (reared in Egypt from seed supplied by J. M. Wallace) and two baladi lime (C. aurantifolia) seedlings; all seedlings were about 1 1/2 years old. To insure further opportunity for virus transmission, one West Indian lime seedling was approach-grafted to each suspect tree. The approach-grafted West Indian lime seedlings were cut from both trees in October 1955.

Two Shamouti sweet orange trees growing on sweet lime rootstock at the Shalakan Experiment Station were found to exhibit bark pitting on the trunk above the bud union and stem pitting on the rootstock (Fig. 2). From the symptoms on the sweet lime rootstock, xyloporosis infection was suspected, but tristeza infection was indicated by bark pitting of the sweet orange top. To investigate the latter possibility four West Indian lime seedlings were budded from one of the two trees and two West Indian lime seedlings from the other.

In a 20-year-old rootstock experiment at Sids in upper Egypt there are 36 Shamouti sweet

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[3]The word "baladi" is Arabic and signifies of the country or of native or local origin.

FIGURE 1. Bark pitting of baladi sweet orange on sour orange rootstock.

FIGURE 2. Bark pitting of sweet lime rootstock with sweet orange top.

orange trees on sweet lime stock. Bark pitting of the trunk above the bud union and stem pitting (wood pitting) of the rootstock were observed on most of these trees. However, 17 Shamouti trees on sour orange did not exhibit bark pitting. The source of the buds from which the tops grew is unknown. There were no baladi orange trees on sweet lime rootstocks in this experiment.

RESULTS

The West Indian and baladi lime seedlings inoculated by budding from the sweet orange trees at Tel El Kebir and at Shalakan have been under continual observation for leaf symptoms of tristeza during the last 2 years. To date no symptoms indicating transmission of the tristeza virus have developed.

In April 1957 both the budded West Indian and baladi lime seedlings and the grafted West Indian lime seedlings were severely pruned, and the pruned branches were carefully peeled and examined for stem pitting, but none was observed. The new growth that appeared following the severe pruning was examined during June 1957, and again no leaf symptoms of tristeza were observed. One of the Shamouti sweet orange trees expressed leaf symptoms of psorosis and the other did not. No symptoms of psorosis were observed on the new growth from the inoculum buds of the two baladi sweet orange trees.

CONCLUSIONS

From these results we believe that bark pitting (honeycombing, pin points, or inverse xyloporosis) of sweet orange growing on sour orange or on sweet lime rootstock is not necessarily an indication of infection with the tristeza virus. This agrees with the interpretation of bark pitting of sweet orange by Cohen and Knorr (4) in Florida. Reichert and Winocour (9) also found that honeycombing of the bark is not specific for tristeza and that there is no anatomical difference in wood projections taken from xyloporosis-infected Shamouti sweet orange trees and wood projections taken from a sour orange rootstock with a sweet orange top infected with tristeza.

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FURTHER STUDIES ON TRISTEZA IN MEYER LEMON IN ARIZONA

J. B. Carpenter[1]

In a recent survey of Meyer lemon trees in Arizona (1) 41 collections of that variety were all found to be carriers of tristeza virus. The next step was to determine whether there had been appreciable spread of this virus from infected Meyer lemons to adjacent citrus trees of other varieties. Previous work in California (4) and Texas (2, 3) has shown that there has been very little if any natural spread of tristeza virus directly from Meyer lemon to other citrus hosts.

Twenty-nine trees growing in groups adjacent to nine Meyer lemons were indexed for tristeza. Each group consisted of two to four trees, comprising various combinations of lemons, thornless Mexican lime, Marsh grapefruit, Valencia orange, miscellaneous sweet oranges, shaddock, Washington navel orange, and Clementine and other tangerines. Even though in the original survey all of the Meyer lemons were found to be infected, each was re-indexed along with the adjacent trees. The indexing was done by grafting buds from each individual collection into a set of three Mexican lime seedlings. This study was begun in April 1956 and continued for 10 months. All 38 sets of index plants, comprising the nine Meyer lemons and 29 adjacent trees, were examined periodically for leaf symptoms. The plants were cut back and the stems which were removed were peeled for evidence of stem pitting in early September 1956 and again in January 1957.

All of the Meyer lemons again gave positive tests for tristeza. None of the 29 adjacent trees gave positive tests for tristeza and, therefore, were presumed to be free of the tristeza virus.

To determine whether the tristeza virus carried by Meyer lemon trees in Arizona will infect species and varieties of citrus other than Mexican lime, the following experiment was made by budding each of the following six combinations in duplicate:

Variety bud	Inoculum bud	Seedling rootstock
Sweet orange	Meyer lemon, No. 154	Ponderosa lemon
Shaddock	Meyer lemon, No. 156	Ponderosa lemon
Lemon	Meyer lemon, No. 158	Ponderosa lemon
Marsh grapefruit	Meyer lemon, No. 162	Ponderosa lemon
Washington navel orange	Meyer lemon, No. 172	Rough lemon
Tangerine	Meyer lemon, No. 175	Rough lemon

The variety buds were all forced; then buds were taken from the resulting shoots of each and grafted into a set of three Mexican lime seedlings. In all instances the inoculated limes developed typical leaf and stem-pitting symptoms of tristeza. This demonstrated that the six varieties studied, representing five of the commercial kinds of citrus in Arizona, plus shaddock, are susceptible to infection by the tristeza virus present in Meyer lemon.

Shoots of the Ponderosa lemon rootstock on the inoculated plants developed stem pitting and foliage symptoms of tristeza, including vein clearing, chlorosis, and distortion, as well as stunting. Conversely, shoots of the inoculated Rough lemon rootstocks were typical, vigorous, and free of tristeza symptoms.

Mexican lime and other indicator plants inoculated with material from Meyer lemon sources in Arizona and the Coachella and Imperial Valleys of California have consistently expressed well-defined leaf and stem symptoms of tristeza. Furthermore, the foliage symptoms and stem pitting on limes inoculated from several of these tristeza sources have been expressed throughout the hot summer weather at Indio, during long periods of daily maxima in excess of 100° F.

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THE FIRST REPORT OF A SPECIES OF HEMICYCLIOPHORA ATTACKING CITRUS ROOTS

S. D. Van Gundy[1]

Abstract

Hemicycliophora sp., an ectoparasitic nematode, was found parasitizing Rough Lemon roots in the Coachella Valley of Southern California. The nematodes were associated with distinctive galls at the distal portion of the terminal and lateral roots.

Specimens of Rough Lemon (Citrus limonia Osbeck) roots showing a peculiar galling were collected from Mecca, California, by Dean Halsey, Farm Advisor of Riverside County. At first glance these galls might easily be mistaken for those caused by root-knot nematodes except that they always occurred at the very tip of the root. Mature root-knot females were not found in any of the galls although two root-knot larvae were found in one gall during sectioning. The galls characteristically occurred as an enlargement of the root-tip, globose to elongate, ranging from 1 to 5 mm in diameter. Figures 1, A and B, illustrate the abundance and typical galling of the roots. Stereoscopic examination revealed a few Hemicycliophora nematodes attached to the galls.

Schindler (4) has described a galling on the root-tips of rose and attributed it to Xiphinema diversicaudatum (Micoletzky) Thorne. He also concluded that Xiphinema was responsible for poor growth and chlorosis of roses in the greenhouse. The symptoms found on citrus are similar to those on slash pine seedlings in Florida as suggested by Steiner (5). He pictures Hemicycliophora sp. attached to small swellings on the roots. DuCharme and Suit (2) recorded Hemicycliophora sp. associated with citrus in Florida but did not describe the pathology. There are other reports by Tarjan (6), Thorne (7), Meyl (3), and Colbran (1) of Hemicycliophora spp. being associated with the roots of various herbaceous plants, but there is no conclusive evidence on the pathogenicity of Hemicycliophora.

Soil samples taken from infested areas in the field contained numerous Hemicycliophora females, males, and larvae, Meloidogyne javanica (Treub.) Chitwood larvae, Trichodorus christiei Allen, and numerous saprophytic nematodes. Soil samples taken from non-infested areas contained all of the above nematodes except Hemicycliophora. An attempt to determine the species from the "Key to Hemicycliophora" (Thorne 7) indicated that this was a new species, a description of which is being prepared for publication by D. J. Raski. Mature females and egg masses of M. javanica were found on the roots of Bermuda grass (Cynodon dactylon (L)) Pers. from the grove, thus accounting for the numerous larvae of this species in the soil and for the chance larvae that may have entered the citrus roots. The population of Trichodorus was low throughout the grove. In the field there was a direct association between galling and Hemicycliophora.

Approximately 90 percent of the galled roots taken directly from the soil and stained in hot acid fuschin lactophenol had from 1 to 150 Hemicycliophora females and larvae attached per gall (Fig. 1, C & D). The nematodes were nearly always attached to the tip of the gall and never were observed on any other part of the root. Fusarium sp., Pythium sp., and Rhizoctonia sp. were found in routine isolations of the root and gall tissue. There was no mycelium nor giant cells associated with the galls in hand microtome sections. The increase in size appeared to be due to an increase in the number of parenchyma cells.

Approximately 50 of 5000 2-to-4-year old Rough Lemon seedlings and Rough Lemon budded to Marsh Grapefruit were found infected with Hemicycliophora. All of the trees were transplanted from a commerical nursery during August 1956. The infected trees occurred in three different permanent grove sites and in five separate areas in the ranch nursery. It

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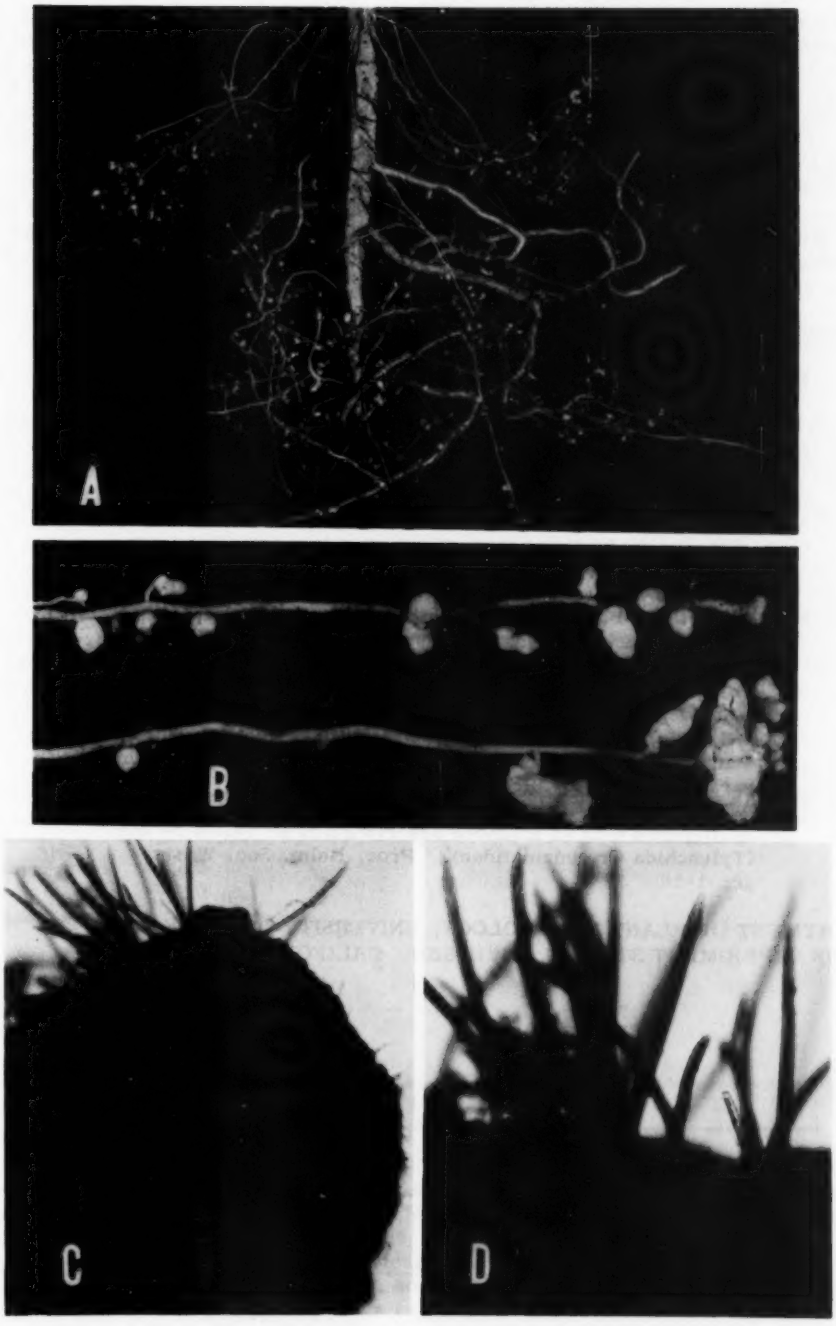

FIGURE 1. A and B, typical galling on Rough Lemon seedling roots; C and D, Hemicycliophora nematodes attached to galls.

seems likely that the initial infection occurred in the commercial nursery and then a few infected trees were scattered when planted on the Mecca Ranch. This commercial nursery had been planted on virgin desert soil but was poorly cared for and failed due to lack of water in August 1956. In the ranch nursery infested areas spread down the irrigation rows for as many as three to six trees. Adjacent rows opposite infested areas and only 2 feet away did not yield trees with galled roots. Likewise, young permanent trees within 6 feet of the infested areas did not show any galling, so it would appear that the buildup and spread of the galling in 1 year was slight.

Information to date indicates that Hemicycliophora sp. is parasitizing Rough Lemon roots and may be the causal organism for an abnormal galling of the root tips. It is not known what effect this severe galling has on the growth and productiveness of citrus. Investigations on the pathology, biology, and control of the nematode, including field and laboratory experiments, are underway.

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OCCURRENCE OF PLANT PARASITIC NEMATODES IN MAINE

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Abstract

Five hundred and twenty-two soil samples from commercially important crops in the State of Maine were examined during 1956 and 1957. Plant parasitic nematodes were found in 41 samples. Pratylenchus was found in strawberries, apples, red raspberries, beans, corn, peas, carrots, and Ladino clover. Paratylenchus was found in beans. Meloidogyne was found in red raspberries and Aphelenchoides was recovered from the roots of apples, beans, corn, and pine seedlings.

The object of this paper is to report the findings of a nematode survey conducted in Maine during 1956 and 1957. The data are from soil and root samples obtained from most of the important commercial crops grown in the State. Most of the samples were taken by the co-authors and the remainder were sent in by county agents and growers. In many cases, particularly from crops showing poor vigor, both soil and root samples were taken. In 1956 nematodes were recovered from the soil samples by means of the modified Baermann funnel technique described by Christie and Perry[1]. In 1957 this technique was replaced by the paper cup filter described by Miller[2]. Nematodes were isolated from root samples by cutting the roots into small pieces and placing them in either a Baermann funnel or a paper cup filter and allowing them to stand 48 hours. By that time most of the nematodes had worked their way out of the root pieces and collected in the bottom of the receptacle. This method seemed to yield better results than chopping the roots in a Waring Blendor.

Table 1. Number of samples containing plant parasitic nematodes from a nematode survey of Maine.

Plant	Pratylenchus	Paratylenchus	Meloidogyne	Aphelenchoides
Strawberry	3			
Apple	3			2
Red Raspberry	1		1	
Peas	2			
Bean	3	3		2
Corn	10			7
Carrot	1			
Ladino clover	1			
Pine seedlings				2
Totals	24	3	1	13

In the 522 samples examined during the 2 years plant parasitic nematodes were found in 41 samples. The meadow nematode (Pratylenchus spp.) occurred in the most crops and in the largest number of samples. Three species, Pratylenchus penetrans, P. pratensis, and P. brachyurus, were identified. Aphelenchoides spp. were isolated from roots of apples, corn, beans, and pine seedlings, all of which showed definite decline. Aphelenchoides was identified in a number of soil samples but not recorded in the Table, since there is doubt that

[1]Christie, J. R. and V. G. Perry. 1951. Removing nematodes from the soil. Proc. Helminth. Soc. Wash. 18: 106-108.
[2]Miller, P. M. 1957. Cheap, disposable filters for nematode surveys. Plant Dis. Reptr. 41: 192-193.

it is a serious plant parasite when occurring in the soil.

Paratylenchus sp. was recovered from three soil samples from beans, and Meloidogyne sp. was isolated from the roots of red raspberry plants.

Dorylaimus sp. was found in large numbers in many of the soil samples examined. Although these nematodes have short stylets, they are not considered to be plant parasites. Over 200 species have been named and they apparently occur in soil everywhere. Very little seems to be known about their feeding habits, however, and further studies are necessary before we can be sure they are not involved in any way in the decline of crops.

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THE EFFECT OF SOIL FUMIGATION FOR THE CONTROL OF PARASITIC NEMATODES ON THE GROWTH AND YIELD OF LOBLOLLY PINE SEEDLINGS

Thomas Hansbrough and John P. Hollis[1]

The production of pine seedlings is expensive and exacting. The gross cost of nursery stock may be several thousand dollars per acre; few, if any, crops are more soil depleting or require more careful soil management practices. These factors, together with increased demands for more and better seedlings, are of much concern to those charged with the responsibility of seedling production and nursery management. In general, a unit of nursery soil tends to produce a constant weight of seedling tissue in the form of either many small seedlings or fewer large ones; therefore, any practice which will insure a maximum production of plantable seedlings is of considerable importance.

It was the purpose of this study to test the general hypothesis that more plantable loblolly pine seedlings of better quality could be grown on a given unit of nursery soil through soil fumigation for the control of plant parasitic nematodes. Nematodes are microscopic eel-worms, many of which feed on the roots of plants. They may be the underlying cause of puzzling ailments in certain nurseries.

Nematologists have established the fact that parasitic nematodes are associated with the roots of all the major southern pines. They have found seven different genera of parasitic nematodes which can attack the roots of loblolly (Pinus taeda), slash (P. caribaea), longleaf (P. palustris), and shortleaf (P. echinata) pine seedlings. A recent survey showed that among several species of parasitic nematodes, Xiphinema americanum Cobb 1913 and Helicotylenchus spp. occurred most commonly in a number of forest soils in Louisiana. Available information indicates that X. americanum may be of considerable economic importance in the southeastern United States, probably as a parasite of trees and shrubs. A species of Helicotylenchus has been established as a parasite of boxwood.

MATERIALS AND METHODS

In order to ascertain the effects of soil fumigation for the control of nematodes and the effects of nematodes on the growth and development of loblolly pine seedlings, an experiment was established at the North Louisiana Hill Farm Experiment Station, Homer, Louisiana, during 1956.

The site selected for the nursery was a portion of an abandoned "old-field" containing scattered pole-sized loblolly and shortleaf pine. The soil type was Lakeland fine sand. An analysis of the soil indicated that nematodes (primarily X. americanum and Helicotylenchus spp.) were present in high numbers.

The experiment included various types of nematocide treatments, with a split-plot design for seedling density superimposed upon each treatment. Seedlings were grown at two densities, 30 and 60 per square foot, on plots treated 2 weeks prior to planting with the following soil fumigants: "D-D"[2] at 25 gallons per acre; "Nemagon"[3] at 7.5 gallons per acre; "Dowfume W-85"[4] at 7.5 gallons per acre; "Dowfume MC-2"[5] at 2 pounds per 100 square feet; and check (no fumigants). The treatments were established on plots 4 feet square in a 5 x 5 latin-square design.

The initial application of fertilizer was made March 8, 1956 at the rate of 600 pounds per acre of 8-8-8 broadcast and mixed into the soil. An additional application of 300 pounds per acre of 8-8-8 was made on the surface between rows on June 25, 1956.

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[2]1, 3-dichloropropene-1, 2-dichloropropane (50-50) mixture supplied by Shell Chemical Corp.

[3]1, 2-dibromo-3-chloropropane (97%) supplied by Shell Chemical Corp.

[4]1, 2-dibromoethane (83%) supplied by Dow Chemical Co.

[5]Methyl bromide (98%), chloropicrin (2%) supplied by Dow Chemical Co.

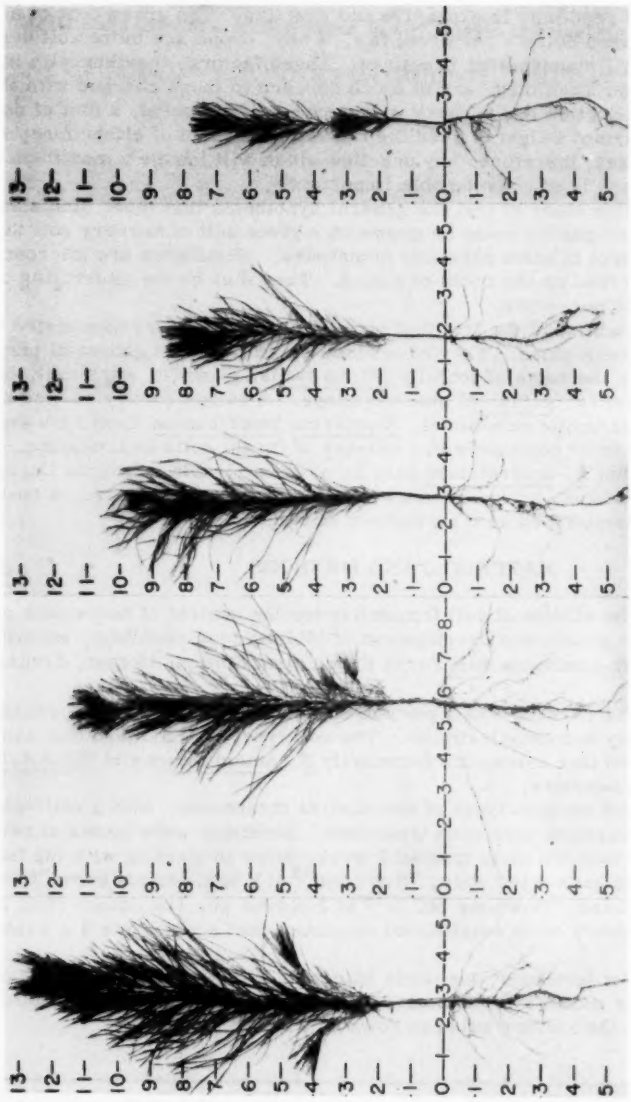

FIGURE 1. Representative samples of loblolly pine seedlings 130 days old grown in plots treated with various nematocides. (Background numbers represent inches)

Soil samples were collected in April, June, July, and September and processed for extraction of nematodes by standard laboratory methods. The nematodes present were recorded as to identity and number in each treatment on each sampling date.

The seedlings were lifted from a depth of 12 inches and graded according to Wakeley's[6] morphological grades during the week of February 3, 1957. The data collected from each treatment-density class were analyzed statistically.

RESULTS

The increased vigor and growth of seedlings (Fig. 1) in the fumigated plots was correlated directly with reduced populations of parasitic nematodes. The first sampling for parasitic nematodes 2 weeks after fumigation showed that they were virtually eliminated from the treated plots. All fumigants were highly effective and there were no differences in initial nematode control. Numbers of the ectoparasitic nematodes X. americanum and Helicotylenchus spp. were suppressed in all fumigated plots throughout most of the growing season. The results suggested that parasitic nematodes were the cause of severe growth reduction of loblolly pine seedlings in the untreated plots.

Table 1 shows the effect of soil fumigation on the production and quality of loblolly pine seedlings grown at the different densities. "Plantable" seedlings include Grades 1 and 2; Grade 3 seedlings are considered "cull."

Table 1. Effect of soil fumigation on production and quality of loblolly pine seedlings grown at two densities.

Treatment	Density at Lifting Per Sq. Ft.	Grade 1 Seedlings Per Sq.Ft.		Grade 2 Seedlings Per Sq.Ft.		Grade 3 Seedlings Per Sq.Ft.		Plantable Seedlings Per Sq.Ft.	
		No.	Pct.	No.	Pct.	No.	Pct.	No.	Pct.
MC-2	31	18	57	11	35	2	8	29	92
D-D	31	17	54	12	38	2	8	29	92
Nemagon	31	16	51	12	39	3	10	28	90
W-85	32	14	44	14	43	4	13	28	87
Check	31	9	31	15	46	7	23	24	77
MC-2	60	15	25	32	53	13	22	47	78
D-D	60	11	19	33	55	16	26	44	74
Nemagon	60	8	13	33	55	19	32	41	68
W-85	60	8	13	33	55	19	32	41	68
Check	60	2	4	29	48	29	48	31	52

Soil fumigation increased the yield of plantable seedlings at both densities. At the lower density, the increase was from 24 to 28 seedlings per square foot, an increase of 17 percent over the non-fumigated yield. At the higher density, the increase was from 31 to 43 seedlings per square foot, an increase of 39 percent over the non-fumigated yield. This increase in plantable seedlings due to fumigation was statistically highly significant.

The maximum production of plantable seedlings was produced by fumigating and increasing seedbed density to 60 per square foot. This combination almost doubled the production per square foot of nursery space. Although the cull percentage was increased even with fumigation, as a result of increased density, the loss resulting from wasted seed was minor compared with all the other economic factors involved in nursery management.

Table 2 summarizes the effect of soil fumigation on height and diameter growth of all seedling grades. Since the seedlings were lifted at the same depth and some of the roots of the larger plants were destroyed, analyses of growth data were restricted to stem height and stem diameter.

[6]Wakeley, Philip C. 1954. Planting the southern pines. U. S. Dept. Agr., Forest Service. Agr. Monog. No. 18, 233 pp., illus.

Table 2. Effect of soil fumigation on the size of loblolly pine seedlings.

Treatment	Grade 1		Grade 2		Grade 3	
	Stem Height (inches)	Stem Diameter*	Stem Height (inches)	Stem Diameter*	Stem Height (inches)	Stem Diameter*
	Seedbed density - 30 per sq. ft.					
MC-2	17.4	8.0	13.7	5.0	10.6	3.0
D-D	16.9	7.6	12.9	5.0	10.7	3.0
Nemagon	15.9	7.8	12.3	5.0	9.9	3.0
W-85	14.3	6.8	11.4	4.8	9.6	3.0
Check	12.4	6.6	9.8	4.2	7.9	3.0
	Seedbed density - 60 per sq. ft.					
MC-2	18.4	7.8	14.0	5.0	11.3	3.0
D-D	16.1	7.0	13.3	5.0	10.7	3.0
Nemagon	16.2	7.2	12.8	4.6	10.2	3.0
W-85	15.3	6.8	12.6	5.0	10.1	3.0
Check	13.2	6.6	10.6	4.0	8.8	3.0

*Diameter measurements in 32nds of an inch, at the root collar.

Table 3. Effect of soil fumigation on the lateral root development of loblolly pine seedlings.

Treatment	Grade 1		Grade 2		Grade 3	
	Number of lateral roots per seedling	Total length (inches)	Number of lateral roots per seedling	Total length (inches)	Number of lateral roots per seedling	Total length (inches)
	Seedbed density - 30 per sq. ft.					
MC-2	25	89	18	46	13	20
D-D	21	82	16	41	12	21
Nemagon	17	79	15	49	9	23
W-85	16	74	14	57	12	29
Check	17	67	12	35	11	22
	Seedbed density - 60 per sq. ft.					
MC-2	24	79	20	50	14	26
D-D	23	77	20	45	12	26
Nemagon	17	55	17	51	12	27
W-85	23	81	17	50	14	26
Check	16	61	14	42	9	18

99 percent of the lateral roots measured originated within 8 inches of the root collar.

Soil fumigation resulted in significantly greater height and diameter growth of Grade 1 and 2 seedlings. Increased density had no detrimental effects on the height and diameter growth of the seedlings within these grades.

Information obtained as to lateral root development, presented in Table 3, further shows the response of loblolly pine seedlings to fumigation. The data show that the lateral root development of seedlings grown on the fumigated soil was much more extensive. Within each grade, more lateral roots with greater total lengths were obtained at both densities.

SUMMARY

The results of this study indicate that the practice of soil fumigation for nematode control offers considerable promise for increasing the production and improving the quality of loblolly pine seedlings in nurseries infested with certain parasitic nematodes.

This experiment, designed to measure the effects of soil fumigation on the growth and development of loblolly pine seedlings, showed the following:

1. The production of plantable seedlings was almost doubled by fumigating the soil and increasing seedbed density from 30 to 60 per square foot.
2. Fumigation of the soil resulted in the production of seedlings with better morphological characteristics within each grade, irrespective of the density.
3. Increased density had no detrimental effects on the morphological characteristics of the plantable seedlings produced.
4. The yield of plantable seedlings was greater on fumigated soil, regardless of density.
5. Soil fumigation was highly effective in reducing populations of parasitic nematodes during the period of active pine seedling growth.

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DIFFERENCES AMONG VARIETIES OF THE DATE PALM IN TOLERANCE OF GRAPHIOLA LEAF SPOT

Roy W. Nixon[1]

Graphiola leaf spot, or false smut, caused by Graphiola phoenicis (Moug.) Poit., occurs on date palms wherever the humidity is continuously high, but it is held in check by low humidity in desert areas best suited to date culture. The fungus and its development were described by Fischer (2) and its relationships worked out further by Killian (3). It was first reported in the United States on greenhouse specimens (4), but later it was found to be world-wide in distribution (1).

Dates are grown in many marginal humid areas where Graphiola leaf spot reduces the fruiting capacity of the palms by causing early death of leaves, but under such conditions the palms are mostly seedlings or inferior varieties in certain localities. However, in southern Texas, where Graphiola leaf spot is definitely a drawback (5), a sizable collection of some of the world's best varieties, seldom seen outside the desert areas, has been grown. This experimental planting of dates was made at Weslaco in the Lower Rio Grande Valley between 1928 and 1938 by the Texas Agricultural Experiment Station (Substation No. 15) in cooperation with the United States Department of Agriculture. After two decades it became apparent that there was no future for commercial date culture in this district. Although the palms have not been fruited in recent years, this planting provided an opportunity to determine whether date varieties vary in their tolerance of Graphiola leaf spot, information which would be of value in a program for selecting or breeding varieties for marginal humid areas.

In 1949 a preliminary inspection indicated that among the different varieties at Weslaco there were differences in the amounts of infection, but a detailed examination of the palms was not made until May 1957. Kustawy and Zahidi, two varieties that appeared to represent extremes of infection, were used as standards to compare the amount of infection in relation to age of leaves in evaluating other varieties. The age of a date leaf can be determined approximately by its position on the trunk in relation to inflorescences, each year's inflorescences being subtended by leaves that emerged the previous year. Five Kustawy palms and six Zahidi palms were compared by counting the number of sori in areas of the same size on ten pinnae in each of the basal, middle, and apical sections of leaves 1, 2 and 3 years of age. The count area was 2 square centimeters (1 x 2 cm) in the middle of each pinna.

Kustawy leaves had consistently fewer sori per unit of area than Zahidi leaves (Table 1). Close inspection revealed slight infection on all leaves by the end of the first year of growth, with measurable, though not conspicuous, differences between the two varieties even at that age. By the end of the second year differences were easily seen and quite striking. After the second year there was no appreciable increase in sorus counts on the apical pinnae, but the number of sori on the middle and basal pinnae gradually increased until by the end of the third year the degree of infection was about the same as on the apical pinnae. This period covered the life span of most leaves, for by the end of the third year few pinnae had much green tissue left and many leaves were dead. Under favorable conditions in the Coachella Valley of California, where 90 percent of the date production of the United States is centered, the life of a date leaf is 6 to 8 years and none is usually removed before the end of the fourth or the fifth year.

Leaves of the Kustawy and Zahidi varieties died at about the same age in spite of differences in the number of sori on the old leaves. This might suggest that the number of sori on the leaves is not an index of the fungus tolerance of the variety in question and that a smaller number of sori might be as injurious to one variety as a larger number to another. This possibility is plausible enough to justify further investigation. However, after many years' observations of date palms under diverse conditions throughout the world the writer is of the opinion that there were probably other unknown causes in addition to Graphiola leaf spot contributing to the death of the Kustawy leaves. Furthermore, because of the earlier and more severe infection it was obvious that the fungus was responsible for a greater reduction in effective green leaf area on Zahidi leaves than on Kustawy leaves.

A few additional sorus counts were made, but the severity of infection on most of the other varieties in the planting was determined by observation only, after carefully selecting

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Table 1. Average number of Graphiola sori per 10 square centimeters of surface on leaves of the Kustawy (K) and Zahidi (Z) date varieties at Weslaco, Texas.

Location of pinnae on leaf	Number of sori					
	1 year leaves		2 year leaves		3 year leaves[a]	
	K	Z	K	Z	K	Z
Basal section	+[b]	0.1	3.7	14.2	9.0	40.0
Middle section	0.3	1.5	6.2	36.8	11.8	39.2
Apical section	1.9	8.7	10.3	47.9	10.3	--[c]

[a]Much of the leaf tissue was dead by the end of the third year so that some of the leaves selected in this group were a few months less than 3 years old.
[b]A few sori were seen on the pinnae in the lower blade, but not in the area of count.
[c]Leaf tissue dead and missing so that counts could not be made.

leaves of approximately the same ages and comparing them with those of Kustawy and Zahidi. Ratings were based primarily on a comparison of 2-year old leaves, which were estimated to have sorus counts averaging from less than 5 per 10 square centimeters on the basal pinnae to less than 15 on the apical pinnae, in light infections, and from more than 10 on the basal pinnae to more than 40 on the apical pinnae, in heavy infections.

The ratings of date varieties at Weslaco, Texas, as to degree of infection of leaves by Graphiola phoenicis are listed below with the country of origin indicated in parentheses.

Light infection: Kustawy (Iraq).
Moderate infection: Amir Hajj, Khadrawy, and Sayer (Iraq).
Severe infection: Ashrasi, Bahrab, Dubaini, Halawy, Khadrawy[2], Khisab, Maktoom, and Zahidi (Iraq); Deglet Noor, Tazizoot, and Thoory (Algeria); Hayany and Saidy (Egypt).

The findings at Weslaco were confirmed by inspection of another planting in which most of the same varieties are represented, near Crystal City, Texas, about 200 miles northwest of Weslaco. This second planting of the Texas Agricultural Experiment Station (Substation No. 19) is a few years younger than the one at Weslaco. The average relative humidity in the Crystal City district is about 10 percent lower than at Weslaco; although Graphiola leaf spot occurs here, infections are less severe than those found in the Lower Rio Grande Valley and the disease has been controlled satisfactorily with bordeaux mixture (5). An inspection of Kustawy and Zahidi palms revealed differences in amount of infection corresponding to those at Weslaco. Seven varieties at Substation No. 19, not in the Weslaco planting, were tentatively rated by comparison with Kustawy and Zahidi as follows:

Light infection: Jozee (Iraq); Tadala (Algeria).
Moderate infection: Ammary (Algeria); Fursi (Iraq).
Severe infection: Bedraya, Braim (Iraq); Koroch (Baluchistan).

These ratings are based on observations only, without careful selection, cutting, and close examination of individual leaves, as was done at Weslaco.

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[2]This variety from southern Iraq is grown commercially in California and Arizona. The Khadrawy listed under moderate infection is a different variety from northern Iraq and is not found in commercial plantings in the United States.

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TWO YEARS' RESULTS OF TESTING CYPREX FOR CONTROL OF CHERRY LEAF SPOT IN MICHIGAN[1]

Donald Cation[2]

Summary

A new spray material, duodecylguanadine acetate (Cyprex), equalled a combination of Glyodin-ferbam in control of cherry leaf spot (Coccomyces hiemalis) in an average year and proved superior in a severe year for infection. The new fungicide corrected lead injury and was effective at 1/2-pound dosage. Eradication was not demonstrated when it was applied within 48 hours of an infection period, but long range protection was indicated. A single test indicated that Cyprex has promise as a sweet cherry fungicide.

A new fungicide, duodecylguanadine acetate, recently named Cyprex, showed exceptional promise for the control of cherry leaf spot (Coccomyces hiemalis) in Michigan experiments of 1956 and 1957. It was equalled in control and foliage retention only by a combination spray of Glyodin and ferbam in 1956 and was superior to that combination in the severe test year of 1957. Fruit from the Cyprex-sprayed trees appeared entirely normal in both years with no browning of the pedicels, although numerical comparisons on sugar content, percent of solids, size of fruit, or yield were not conducted.

The standard spray comparisons are made on single tree plots replicated five times. Four sprays are applied. The first of the three preharvest sprays is applied at petal fall and the other two at approximate 10-day intervals. The fourth spray is applied soon after harvest. Two pounds of lead arsenate are added to each 100 gallons of spray in preharvest applications, a standard insecticidal practice in Michigan. Observations are made throughout the season but a comparison of the number of leaves held or lost in the fall usually gives an indication of the relative value of the different treatments.

1956 RESULTS

1956 would be considered an average year, with most materials giving a fair degree of control whereas unsprayed checks were completely defoliated. The data presented in Table 1 indicate the final condition of the plots.

From an examination of these data it is apparent that the Cyprex treatments and the Glyodin-ferbam combination gave equal results and that both were superior to the other treatments. A 2-pound dosage of the Omadine-manganese salt was necessary to approach ferbam in control value. The weaker dosages failed. The copper-lime combination held leaf spot perfectly throughout the season but several waves of injury occurred at different times accounting for leaf loss. Arsenical injury was not conspicuous in the spray plots but was severe in nearby trees sprayed with Glyodin alone without a corrective.

1957 RESULTS

Comparisons were continued in 1957, using similar plots and timing of applications. Omadine-zinc salt and Omadine-copper salt were substituted for the Omadine-manganese salt. Ferric iron sulfate was compared with ferbam for correction of lead arsenate injury in combination with Glyodin. Actidione at 1 ppm was combined with 1 1/2 pounds of ferbam to determine whether this combination was of value.

1957 was an outstanding year at Shelby, Michigan, for evaluating fungicides for the

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Table 1. Defoliation per 100 spurs following four spray treatments on Montmorency cherry at Shelby, Michigan, October 14, 1956.

Materials and amounts per 100 gallons	Average of leaves absent from spurs (number)
Cyprex[a] 1 pound	3
Cyprex[a] 1 1/2 pounds	4
Glyodin 1 1/2 pints - ferbam 1/2 pound	4
Tenn. 26 copper 3 pounds - lime 3 pounds	31[c]
Captan 2 pounds	59
Ferbam 1 1/2 pounds	112
Omadine-Manganese salt[b] 2 pounds	122
Omadine-Manganese salt[b] 1 pound	274
Omadine-Manganese salt[b] 1/2 pound	279

[a]Supplied by the American Cyanamid Company.
[b]Supplied by the Olin-Mathieson Company.
[c]Defoliation on this plot resulted from injury.

control of cherry leaf spot. In the vicinity of the spray plots there was a prolonged bloom. Light infection was established before the first spray was applied. The preharvest spray dates were May 26, June 6, and June 18. The after-harvest spray was applied August 8. Thus 50 days intervened between the third and fourth spray. Following the third preharvest spray of June 18, precipitation totalling 8.14 inches was recorded for 14 of 30 days between June 22 and July 22. This excess of rain served to reduce protective spray residue and provided ideal conditions for a progressive increase of inoculum. Where previous sprays were not completely effective and protective residues were diminished, the rain of July 22 initiated large scale infection and defoliation. Under these conditions ferbam, captan and Omadine-zinc sprayed trees were showing so much infection at harvest time that they were removed from the comparative tests and sprayed with Actidione at 2 ppm. The other materials tested held the disease in check although the final counts on defoliation from terminal growth, as presented in Table 2, demonstrated wide differences in final control.

An examination of Table 2 shows that Cyprex, even at 1/2-pound dosage, was outstanding in control of leaf spot under the severe conditions of the test. Cyprex also corrected lead arsenate injury. The trees receiving the other treatments gave a final appearance better than their defoliation count indicates, but the loss of terminal foliage approximates their relative standing. The Glyodin-ferbam combination was an exceptionally good treatment for Montmorency. The ferbam added as a corrective for lead arsenate injury also contributed materially to leaf spot control, as indicated by the comparison with ferric iron sulfate. The combination of ferbam and Actidione was effective but injury was apparent on young foliage. The copper containing materials gave good leaf spot control but showed more injury than is usually experienced.

Opportunity for another test was offered in 1957. Observations in an adjacent orchard disclosed considerable inoculum uniformly present as a result of insufficient spraying. It was also expected that the wet period of July 22 would promote further severe infection and defoliation. To determine possible back action, Cyprex at 1 and 1 1/2 pounds per 100 gallons was compared with Actidione 2 ppm plus B1956, a hyamine wetting agent. The sprays were applied on July 24, 2 days following the infection. Under these conditions Cyprex was at first considered a failure, as the yellowed leaves showing on August 4 indicated no back action. However, after this wave of yellow leaves had fallen the Cyprex-sprayed trees indicated satisfactory foliage retention for the remainder of the season. Conversely, in adjacent rows the Actidione treatment contained the July 22 infection, but in further contrast to the Cyprex

Table 2. Defoliation from terminals of Montmorency cherry at Shelby, Michigan, October 4, 1957, as influenced by spray treatments.

Materials per 100 gallons of spray[a]	Leaves present (number)	Leaves absent	
		Number	Percent
Cyprex 1 pound	1856	64	3.3
Cyprex 1/2 pound	1501	86	5.4
Glyodin 1 1/2 pints, plus Ferbam 1/2 pound	1206	800	40.0
Omadine-copper salt 1 1/2 pounds	606	756	55.5
Ferbam 1 1/2 pounds, plus Actidione 1 ppm	688	902	57.0
Glyodin 1 1/2 pints, plus Ferbam 1/2 pound	708	1244	64.0
25% copper, 3 pounds, plus lime 3 pounds	390	800	67.0
Control (not sprayed)	--	--	100.0
Removed from the test --			
Ferbam 1 1/2 pounds	--	--	--
Captan 2 pounds	--	--	--
Omadine-zinc salt 1 1/2 pounds	--	--	--

[a]Lead arsenate at 2 pounds in 100 was included in each treatment as the standard insecticide.

treatments, the Actidione plots were reinfected during the fall rains and the trees were defoliated by October 4. There was some indication that wetting agents reduced the effectiveness of Actidione, as other applications of Actidione alone produced better control.

In another large scale test in a 30-year-old orchard, using a 6 X concentration, Cyprex at 6 pounds per 100 gallons as one treatment, compared with a combination of Glyodin 9 pints plus ferbam 3 pounds per 100 gallons as the standard treatment, were applied with a mist blower in a 4-spray program at the rate of 3/4 gallon per tree. Both treatments indicated commercial control. No leaf spot was evident at any time on the Cyprex plots, but with the Glyodin-ferbam mixture there was a trace of infection at harvest time and also at the end of the season. Since serious defoliation did not occur both treatments were considered satisfactory for practical usage.

On November 3 all trees used in the standard spray comparisons except those sprayed with Cyprex were completely bare. The Cyprex trees stood out conspicuously with an estimated 35 percent foliage retention although the remaining leaves were gradually falling and no longer normal green in color. Whether this phenomenon is related to disease control or physiological action affecting leaf retention is a matter for further study. Nevertheless this fact seems worthy of note and record.

Only one comparison of Cyprex was made on sweet cherry. On June 6, 1957, two plots of 20 Bing trees each were comparatively sprayed with Cyprex at 1 1/2 pounds and the combination of Glyodin 1 1/2 pounds and ferbam 1/2 pound per 100 gallons. Two pounds of lead arsenate were included with each treatment. Within a week in the Glyodin-ferbam plot several large intermediate leaves on each terminal growth turned red and fell off. No injury could be noticed on the Cyprex-sprayed trees. Although leaf spot was not a factor in this limited test, the lack of injury indicated that on further testing Cyprex may prove of value as a sweet cherry spray.

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COLLETOTRICHUM ATRAMENTARIUM IN FIELD TOMATOES

Blair H. MacNeill

The existence in Ontario of Colletotrichum atramentarium (Berk. & Br.) Taubenh., the causal agent of a rootrot of greenhouse tomatoes, has been recognized for some time. Under greenhouse conditions affected plants wilt and exhibit marked vascular discolouration when the stem is viewed in longitudinal section. Incubation of the affected root tissue readily reveals the presence of C. atramentarium, and the relationship of this organism to the rootrot condition has been established experimentally[1].

Recently the presence of C. atramentarium has been noted in tomatoes in the field. In August, 1956, a field of tomatoes in the Aldershot, Ontario area was observed to develop wilt and exhibit symptoms generally characteristic of the Fusarium wilt disease. Yet, repeated attempts to isolate Fusarium from affected plants were unsuccessful; rather, the only fungus which appeared to be consistently associated with the wilt condition was C. atramentarium. This was felt to be especially significant since the disease had appeared at a time when soil temperatures were perhaps too low for Fusarium to be highly aggressive.

During the past 1957 season, another outbreak of this disturbance in tomatoes was discovered; this time in a field in the Woodstock, Ontario district. In this instance, samples taken in September throughout the 10-acre planting indicated that almost all of the tomatoes were affected to some degree, substantiating the observation made earlier in the season that a wilt disease was rather general in the field. When tissue taken from plants showing severe symptoms was incubated, C. atramentarium again was obtained as in the previous year. However, in this more recent series of isolations the fungus was found not only in the tissue of the roots but also in the vascular cylinder of the lower stem, the "sclerotia" of the fungus actually being visible in the stele.

On the basis of these observations it is suggested that:

1) C. atramentarium apparently is able to make at least limited systemic invasion of its tomato host, and this under certain field conditions may lead to a general breakdown of the plant;
2) the diagnosis of "wilt" in field tomatoes from symptoms alone may readily lead to an error in etiology.

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[1] MacNeill, Blair H. 1955. Colletotrichum rootrot of greenhouse tomatoes. Plant Dis. Reptr. 39: 45-46.

GRISEOFULVIN, LITHIUM SALTS, AND ZINC GLASS FRIT FOR CONTROL OF CABBAGE CLUB ROOT

Saul Rich

Summary

Griseofulvin is effective in controlling club root when applied as a soil treatment. Zinc glass frit reduced the amount of disease but lithium salts were ineffective when applied as soil treatments. There was no correlation between severity of clubbing and height of plant.

No downward translocation was detected when griseofulvin was applied to foliage. Therefore, this compound must be applied as a soil treatment to be effective as a control measure.

INTRODUCTION

Griseofulvin, lithium salts, and glass frit containing 23% zinc oxide[1] were tried as soil treatments for the control of club root of cabbage (Plasmodiophora brassicae). Griseofulvin was chosen because it is a very stable antifungal antibiotic previously untested for the control of club root. The lithium salts were chosen because ions of other alkali metals and alkaline-earth metals greatly influence the development of club root. The choice of zinc glass frit was based on the 1956 report by Tomlinson (8) that the material would control crook root disease of watercress caused by Spongospora sp., a related organism.

Since the beginning of this experiment, there have been four reports of the use of griseofulvin for the control of club root. Last (4) reported that he and McFarlane were able to reduce club root infections with griseofulvin in greenhouse experiments. Potter (5, 6) gave further details of the work of Last and McFarlane. Potter's first report (5) indicated that griseofulvin applied to cabbage foliage acted systemically against club root. The second report (6) stated that there was no downward translocation of griseofulvin in the plant, but that the antibiotic had dropped off from the leaves and had acted in the soil, rather than as a systemic material. Rosser (7) found that although griseofulvin did not reduce the amount of the disease in field trials, the griseofulvin treatment did result in a significant increase in the number of marketable cabbage heads.

CLUB ROOT CONTROL

Air-dry soil was mixed with club root inoculum. Griseofulvin was mixed dry with the dry soil at two doses: 20 mg and 40 mg per kilo of dry soil. Solutions of lithium hydroxide, carbonate, sulfate, and fluoride, were watered on the dry soil to give a final concentration of 125 mg of lithium salt per kilo of dry soil. Zinc frit was mixed dry with the dry soil at the rate of 1,000 mg frit per kilo of dry soil. The treated soil was placed in containers, watered, and planted the following day with seedlings of Michihli variety Chinese cabbage. For each treatment there were 10 containers of soil, each with a single plant. The original pH of the untreated soil was 6.05. Data were taken after 4 weeks. The results are given in Table 1.

The final pH of the soil, which ranged from 6.20 to 6.48, was not a factor in disease development differences in this experiment. Within individual plants there was no correlation between club grade and size of plants. There appeared to be some slight stunting at the higher concentration of griseofulvin. The lithium salt treatments did not reduce the amount of club root. Zinc glass frit reduced the amount of club root. Griseofulvin definitely controlled club root.

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[1] These materials were supplied gratis by the following concerns: griseofulvin by Merck and Co., Inc., Rahway, New Jersey; lithium salts by Foote Mineral Co., Philadelphia, Pennsylvania; and zinc glass frit by Ferro Corp., Cleveland, Ohio

Table 1. Club root development and plant growth of Chinese cabbage plants in club root-inoculated soil treated with griseofulvin, lithium salts, and zinc glass frit.

Treatment	Concentration in mg/kilo dry soil	Number of plants (of 10) showing clubs	Average club grade* of clubbed plants	Average length of longest leaf (mm)
Griseofulvin	20	2	2.5	75
Griseofulvin	40	2	2.5	71
Lithium hydroxide	125	9	3.0	85
Lithium carbonate	125	10	3.1	91
Lithium sulfate	125	10	3.9	84
Lithium fluoride	125	9	4.2	80
Zinc glass frit	1000	6	3.3	79
Check	—	10	4.2	75

*Club grades: 1 = small swellings on roots.
2 = large swellings on roots.
3 = small swelling at base of stem.
4 = large swelling at base of stem.
5 = both roots and stem base clubbed.

TESTING FOR DOWNWARD TRANSLOCATION OF GRISEOFULVIN

As soil treatments in the field are expensive and difficult, a material which could be applied to foliage and would act systemically against club root would be most useful. Griseofulvin, which is effective against club root, is known to be a systemic fungicide (2). Will it translocate from foliage to roots? This was tested in the following experiment.

Michihli Chinese cabbage seedlings were transplanted through holes into sealed 1/2-pint waxed cardboard food containers filled with sand, and were fed with soluble nutrients. Eight plants were used in each treatment. The plants were treated by dipping the leaves into the treating solution. The treating solutions were griseofulvin at 50 ppm and at 100 ppm, and a water dip for the checks. After being dipped the plants were supported in an inverted position until the leaf surfaces were dry. The plants were dipped on June 24, and again the next day. The plants were about 75 mm tall when treated. On July 1, the tops of the plants were cut off, the containers opened and the roots harvested. Each root was extracted separately using the chloroform technique described by Crowdy et al. (3). The roots were ground in a mortar under chloroform, then macerated in a Waring Blendor under chloroform. The mixtures of macerated roots and chloroform were allowed to stand for 7 days, and then reflux-extracted for 2 hours. The separate chloroform extracts were reduced in volume, placed in individual depression slides, and evaporated to dryness at room temperature. After the slides were completely dry, the depressions were filled with a spore suspension of a Botrytis species isolated from strawberries. The spores were incubated overnight. None of the germ tubes showed the curling abnormalities characteristic of griseofulvin (1). There was no evidence, therefore, of the downward movement of griseofulvin from foliage to roots.

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PEA BEAN RUST IN NEW YORK STATE

Walter H. Burkholder

The dry shelled beans that are grown extensively in New York State are the Red Kidney, the Perry Marrow, and the pea beans. The variety Michelite constitutes the greater part of the pea beans grown, with an occasional field of Robust and of Monroe. There is also a limited acreage of Yellow Eye, White Kidney, and Black Turtle Soup beans.

In the western and northern parts of the State where these beans are grown, only the pea beans are subject to the rust fungus, Uromyces phaseoli typica Arth. The race of this fungus that infects the pea beans evidently is unable to attack the other dry beans, at least the disease has never been observed on the latter. Rust is found in the State on some garden beans also. The Kentucky Wonder is particularly susceptible. The race that attacks this variety is no doubt different from that on the pea beans, since on Kentucky Wonder the rust may appear early in July and cause severe damage, whereas on pea beans rust has never been found until late August or early September.

On pea beans the symptoms of the disease are very evident. Sori full of brown spores and surrounded by a yellow halo appear over the surface of the green, late-developing leaves that are borne near the end of the runners; the urediospores are produced in these sori. On the older and lower leaves that are beginning to turn slightly yellow the green-haloed sori contain dark brown spores, the teliospores. The rust has not been observed on the pods.

The effect of this disease on the bean plants is defoliation which progresses fairly rapidly after infection becomes general. Since, however, the rust does not appear on pea beans until late, that is, when the pods are maturing, little or no damage is caused to the plant. In fact, it is rather an advantage to have the disease appear at this time of year, when the grower wants his beans to ripen rapidly to avoid an early frost; also, in many instances, he wants to pull and remove the beans from the field in order to prepare the land for winter wheat. With the aid of the rust fungus he is able to ripen the beans at a reasonable date.

A grower of other varieties of dry beans may apply a defoliant at this time if his crop is not maturing rapidly. Unfavorable weather conditions, such as wet cloudy weather, may delay ripening. The defoliant and the rust act similarly. Thus, pea bean rust in New York State is not a disease to combat, but is, rather, something of a benefit. It is true that the average grower does not know what it is that defoliates and matures his pea beans in early September. He does not worry about it, but keeps on planting pea beans to insure an early September crop.

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RESISTANCE TO THE GRAY LEAFSPOT DISEASE IN BLUE LUPINES[1]

Ian Forbes, Jr., Homer D. Wells, and John R. Edwardson[2]

Abstract

The discovery of resistance to the gray leafspot disease caused by Stemphylium solani Weber in strains of blue lupine (Lupinus angustifolius L.) is reported. An artificial greenhouse inoculation technique is described which appears to be satisfactory for use in breeding forage varieties carrying resistance to gray leafspot.

Wells et al.[3] reported the widespread occurrence in Georgia and Florida of the gray leafspot disease caused by Stemphylium solani Weber on blue lupine (Lupinus angustifolius L.). Severe damage was observed at some locations, indicating that gray leafspot can seriously reduce forage and seed production when the environment is favorable for the pathogen. Since the only forage variety in use, Borre sweet blue lupine, is highly susceptible, a search for blue lupine plants having resistance to this disease was initiated as the first step in breeding a resistant forage variety. Concurrently with the search for resistant plants, an inoculation technique was developed for screening hybrid populations segregating for gray leafspot resistance.

The following inoculation technique was used. Seed lots to be tested were planted in triplicate in steam-sterilized soil in 4-inch clay pots (10 seeds per pot) in the greenhouse. On the same day cultures of S. solani were transplanted to Petri dishes containing sterilized "V-8" juice agar. Following incubation of the cultures at room temperature for 7 days and in an east window for 7 days, they were ground 30 seconds in 5 volumes of water in a Waring-Blendor and sprayed on the 14-day-old plants. Following inoculation the plants were placed in a chamber and subjected to intermittent fog for 2 days and then returned to the greenhouse benches. Disease reaction ratings were made 14 days after inoculation. A rating of 0 represented no infection, and a rating of 5 represented very heavy infection with plants being almost defoliated or killed (Fig. 1).

Two inoculation tests were conducted. The first test comprised 44 seed lots from the United States, Europe, and New Zealand. Highly significant differences were observed in disease reaction among plants from the different seed lots, ranging from susceptible to resistant (Table 1). Based on the results of the first test, seeds of 10 resistant and 4 susceptible strains were planted in 8 replications (10 seeds per pot). These plants were inoculated as previously described. The results of the second test (Table 1) confirmed those of the first test, indicating a reliable technique.

The forage variety Borre sweet blue lupine was highly susceptible to the pathogen, as were common bitter blue, Alta, Florida #2, and several foreign introductions. Highly resistant strains were PI 167938-S1, PI 167938-S2, PI 167940-S3, PI 167940-S4, PI 168525-S5, PI 168526-S6, PI 168527-S7, PI 168530-S8, PI 168530-S9, PI 168533-S10, PI 168535-S11, PI 168535-S12, and Gainesville S13.

Gainesville S13 is the most vigorous and productive of the resistant strains and is the only resistant line tested which has a desirable soft seed coat character. This line arose from a few plants selected from a 10-acre blue lupine planting which died prematurely at Gainesville, Florida, in 1953. Infection by S. solani is now suspected as being a major cause of the premature dying. Although the strain contains a bitter, poisonous alkaloid (lupanin) in

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[1]Cooperative investigations at Tifton, Georgia, and Gainesville, Florida, of the Crops Research Division, Agricultural Research Service, United States Department of Agriculture, the University of Georgia College of Agriculture Experiment Stations, and the Agricultural Experiment Station of the University of Florida. Published with the approval of the Director of the Georgia Coastal Plain Experiment Station, Tifton, Georgia, as Journal Series Paper No. 48.

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[3]Wells, Homer D., Ian Forbes, Thomas E. Webb, and John R. Edwardson. 1956. Two Stemphylium diseases of blue lupine. Plant Dis. Reptr. 40: 803-806.

FIGURE 1. Blue lupine plants 14 days after inoculation with Stemphylium solani. Pot at left contains susceptible Borre sweet blue. Pot at right contains resistant Gainesville S13.

Table 1. Results of artificial inoculation of blue lupine populations with Stemphylium solani in 1957 at Tifton, Georgia.

Test and seed lots description	Frequency distributions of disease reaction averages [a] Class centers					F values [b]
	0.5	1.5	2.5	3.5	4.5	
First test -- all accessions	2	9	14	12	7	33.5
Second test -- selected accessions	10	--	--	--	4	310.8

[a]Average disease reaction of 3 replicates in first test and 8 in the second. Disease reaction: 0=immune; 5=plants killed.
[b]Both F values were greater than that required for significance at the 1% level.

its foliage, this characteristic is controlled by a single pair of genes. Hybrids between the selection and sweet (non-alkaloid) plants should give rise to segregates combining S. solani resistance, sweetness, and good forage production. The inoculation and screening technique described is considered adequate for the detection of resistance and for studies of the inheritance of resistance to S. solani in blue lupine.

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MAINTAINING BACTERIAL ORGANISMS IN SOYBEAN LEAVES[1]

Donald W. Chamberlain[2]

Summary

Pseudomonas glycinea, the soybean bacterial blight organism, has been maintained in leaves at 5° to 7° C for 7 years without loss of viability or virulence. Infected leaves from the field or greenhouse are equally effective when used directly as inoculum. It is easier, however, to isolate the organism from leaves grown in the greenhouse because they are virtually free of contaminating organisms. Cold-storage likewise proved to be an effective method for preserving Pseudomonas tabaci in soybean leaves. Virulent cultures of the organism were isolated after 3 1/2 years storage at 5° to 7° C. Neither of these organisms lived beyond 2 months in leaves stored at laboratory temperature (24° to 35° C).

Maintaining cultures of the soybean bacterial blight organism (Pseudomonas glycinea Coerper) has been one of the major problems encountered in working with this disease. In culture, the pathogen often dies unless it is transferred frequently to fresh media, and it does not long survive at laboratory temperatures above 33° C. At some locations, cultures of P. glycinea have been maintained under mineral oil for long periods (2), but this method has not been generally successful. In Illinois, it is impossible to isolate the organism from dried leaves stored for more than 6 weeks at laboratory temperatures (24° to 35° C).

The wildfire organism, Pseudomonas tabaci (Wolf & Foster) F. L. Stevens, likewise presents a problem because it tends to lose pathogenicity or viability in culture on some of the common laboratory media. In Illinois, it is impossible to isolate the organism from dried soybean leaves stored at laboratory temperatures (24° to 35° C) for 2 months. Under the same conditions, P. tabaci remains viable in dried tobacco leaves for more than 12 months.

In December 1949, leaves of Lincoln soybeans that had been inoculated in the greenhouse with Pseudomonas glycinea were placed in a Petri dish and stored in an ordinary refrigerator at 5° to 7° C. Isolations made from these leaves in July 1952 showed that abundant viable bacteria were present. Greenhouse inoculations of the isolates to susceptible soybeans indicated that virulence was undiminished. On July 20, 1952, ten infected leaves from the greenhouse were placed in the refrigerator at 5° to 7° C, while a similar lot was stored in the freezing unit at -10° C. Leaves infected with P. glycinea in the field were also stored in the 5° to 7° C. refrigerator. In all cases the leaves were permitted to dry out naturally in storage, with no attempt made to control the relative humidity in either the laboratory or the refrigerator.

When the organism was reisolated and tested for pathogenicity in December 1956, abundant and virulent bacteria were still present in leaves collected both from the greenhouse and from the field. For the original lot, this represents a storage life of 7 years; for the second lot (July 1952), 4 1/2 years. There was no perceptible difference in virulence or viability between bacteria isolated from leaves stored at 5° to 7° C and those stored frozen. The preservation of P. glycinea for 31 months at -18° C has been reported by Frosheiser (1).

One difference worthy of consideration was noted between infected leaves collected in the field and those from the greenhouse. Leaves from the field carried many contaminants, while leaves from the greenhouse were relatively free of organisms other than P. glycinea. Consequently, it was much easier to isolate a pure culture of the organism from the latter. When leaves were used directly to prepare inoculum, leaves from field or greenhouse were equally satisfactory. Whether they were stored in Petri dishes, paper bags, or wax paper made no apparent difference. For inoculum, three or four leaflets with approximately 10 percent of their area covered by blight lesions were beaten in 200 ml. of water for 3 minutes

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[1]Publication No. 302 of the United States Regional Soybean Laboratory, Urbana, Illinois.

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in a Waring Blendor. The coarse fragments were filtered out with a cheesecloth pad, and the bacterial suspension was made up to 1 liter. For field inoculations, it was found convenient to prepare a more concentrated bacterial suspension by increasing the number of leaves in the Waring Blendor. Suitable dilutions of the concentrate were made in the field by adding water.

Storage at 5° to 7° C was tried as a method of preserving Pseudomonas tabaci in soybean leaves. Infected leaves of the Lincoln variety were placed in the refrigerator on July 15, 1953. Isolations from these leaves in December 1956 yielded abundant populations of the organism; tests for pathogenicity on young soybean plants showed no apparent change in virulence. This represents a storage life of 3 1/2 years for P. tabaci in soybean leaves stored at 5° to 7° C in contrast with a maximum life of less than 2 months when stored at 24° to 35° C.

It is suggested that the greatly increased longevity of both organisms at low temperatures may help to explain the survival of P. tabaci and P. glycinea from one season to the next in a climate similar to that in Illinois.

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ALFALFA WILT IN CHILE

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Alfalfa culture has ancient roots in Chile for it was established with the Spanish settlements in this part of the new world. The Inca Indians adopted the crop for their pastures wherever fertile valleys were cultivated. Nevertheless, the use of alfalfa for pasture has not kept pace with the expanding agriculture of the country, and at present only 100,000 hectares (250,000 acres) are planted to this crop. Alfalfa production has a rather limited range, being confined primarily to the areas 200 miles around Santiago, and in the irrigated valleys of the northern deserts. A concentrated effort is now under way to expand the hectarage of alfalfa as a base for increased milk and meat production.

The farmers have been aware that something was amiss in the culture of alfalfa for their fields needed reseeding much more frequently than formerly. Within the past few years a number of plants with the typical syndrome of alfalfa wilt have been observed. The symptoms were a sparse re-growth of the crown after cutting, and weak, sometimes chlorotic, plants. Cross-sections of the root revealed a discoloration of the vascular ring which, in later stages of the disease, extended toward the center of the root. In view of the large role planned for alfalfa culture, the presence of this disease was cause for alarm, and further study on alfalfa wilt became essential. The ultimate aim is to breed varieties of alfalfa resistant to the wilt which are suited to Chilean conditions. Three types of information had to be obtained before such a program could be put on a firm basis. First, the extent and distribution of the disease had to be determined. Second, the exact nature of the wilt had to be proved. Third, if it really was bacterial wilt, the Chilean strains would have to be isolated and used in subsequent tests for the resistance of the crosses.

An attempt was made to survey fields in most of the alfalfa growing areas of the country. Fifty-one fields were examined from the northern Arica region of desert valleys to the southern end of the central valley at Osorno. Included in the survey was alfalfa grown in the high Andean valleys, as well as at sea level on the Pacific coast. The plants that were examined included varieties which are most commonly grown in Chile; some of these types are unnamed, having been used locally for many years. Among such alfalfas were some regional varieties that are used by the highland Inca Indians, and probably have been grown for hundreds of years. Other varieties were well known such as Chilena, Peruana, Ranger, Provence, and Caliverde. All fields were observed for crown symptoms; plants showing the typical syndrome were examined for root symptoms. In addition, approximately equal numbers of plants, in which no external symptoms were evident, were observed for root symptoms. Plants showing evidence of root infection from both groups were later used for isolation of the bacterial pathogen. These bacteria were then stained and examined to determine the Gram reaction

Plants showing the symptoms of bacterial wilt were present in all the fields that were examined (Table 1). Whenever the field showed obvious symptoms of disease, such as a general thinning with weak growth, or spots where individual plants seemed chlorotic and not vigorous, root symptoms were present. The examination of roots of seemingly healthy plants often showed that the disease was also present in such plants; a darkening of the vascular system was sometimes very obvious while at other times only slight discoloration could be observed. Evidence of the disease was found in plants of various ages ranging from 1 to 10 years. Apparently the pathogen gets an early start. Generally, the amount of damage was greater in old fields with a decreasing order of intensity in the younger fields. Thus of four fields at Hacienda Camarones, the disease was strongest in the 15-year-old field and moderate, weak, and trace in the 10-, 6-, and 1-year-old fields, respectively. On the other hand, even young fields were at times severely damaged. One field near Rinconada de Maipú had an estimated 25 percent decrease in stand after the first year, with strong root symptoms in many of the surviving plants.

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Table 1. Observations on alfalfa wilt in various parts of Chile.

Area	Location of fields examined	Variety	Age in years	Wilt attack
Valle Lluta	Libanesa	Native	3	Weak
	Libanesa	High mountains	5	Strong
	Caja de Colonizacion	High mountains	10	Strong
	Bayzan	High mountains	5	Strong
	Potrero Km. 36	High mountains	5	Strong
Valle Azapa	Mournauntani 3600 mts.	High mountains	10	Strong
Valle Chaco	Socavon	Alfalfa from south	3	Weak
	Socavon	of Chile	5	Weak
Valle Camarones	Bota	Native to region	10	Moderate
	El Peral	Native to region	6	Very weak
	La Tranquilla	Native to region	1	Trace
	Huancarani 1600 mts.	Native to region	15	Strong
Vallenar	Las Ventanas	Caliverde		Strong
Prov. Coquimbo	Fray Jorge	Peruana		Strong
Los Andes	Km. 23 from Santiago	Peruana		Strong
	Km. 51 from Santiago	Peruana	5	Strong
	El Castillo	Peruana	5	Strong
	Santa Rosa	Peruana and	2	Strong
		Caliverde	4	Strong to roots
	San Vicente	Caliverde	4	Moderate
	El Sauce	Caliverde	2	Moderate
		Peruana	10	Strong
Ocoa	Vista Hermosa	Caliverde	3 1/2	Moderate
	Vista Hermosa	Peruana		Strong
	Vista Hermosa	Ranger		Strong
	Vista Hermosa	Provence		Strong
Lampa	Gonzalo Barros	Caliverde	2	Weak
	Lo Vargas	Certified Caliverde (U. S. A.)	4	Strong
	Cruces Polpaico con Panamericana	Unknown		Strong
Maipú	Rinconada	Peruana		Strong
	4 fields between Maipú and Santiago			Strong
Paine	3 fields	Caliverde	2	Strong
Llolleo	Las Brisas	Peruana	10	Strong
	Las Brisas	Peruana	3	Weak
Isla Maipo			2	Strong
Requinoa	Las Cabras	Unknown	2	Strong
Rancagua	Km. 19	Unknown	4	Moderate
	Km. 22	Unknown	3	Moderate
	Rancagua	Unknown	3	Moderate
	Sud Rancagua	Unknown	3	Moderate
	Polonia S. E.	Unknown	4	Moderate
Talca	Santa Carolina	Unknown		Moderate
	Las Cruces	Unknown		Moderate
	San Carlos	Rhizoma	1	Trace
Osorno	Experiment Station			Moderate

Table 2. Reaction of different varieties at Los Andes to alfalfa wilt (alfalfa seeded in 1956).

Variety	Wilt reaction	Variety	Wilt reaction
Peruana	Strong	Flamand	Strong
India	Weak	Tagiura	Very strong
African	Strong	Giante de Crimona	Strong
Arica	Strong	Venecia 26	Strong
Pilca Butta	Moderate	Italia Central	Moderate
Sevelra	Strong	Vernal	Very strong
Franconia	Strong	Northern	Strong
Southern	Strong	Grimm	Very strong
Polpaico	Very strong	Atlantic	Very strong
Caliverde	Strong	Ladak	Moderate
Cuicolco	Very strong	Ranger	Very strong
Buffalo	Strong	Nermasten	Very strong
Du Puits from Holanda	Strong	Nomad	Very strong
Provence	Very strong	Rhizoma	Strong
Du Poitou	Strong		

Table 3. Severity of Root Symptoms in Caliverde

Disease Rating	Number of Plants
0	0
1	2
2	35
3	90
4	35
5	1

All varieties that were encountered in commercial plantings showed symptoms of alfalfa wilt. Peruana, Chilena, and many indigenous alfalfas were very susceptible; at the other end of the scale, Caliverde seemed relatively resistant. Even when Caliverde was attacked by the pathogen, the amount of damage, measured by the appearance of the plants and the number of cuttings that can be obtained each year, was negligible. On one fundo (large farm) this was dramatically seen because Ranger, Peruana, Provence, and Caliverde were grown side by side. Caliverde had the least amount of disease and had double the yield of the other varieties. A study of 29 alfalfas in a variety trial at the Estación Genética at Los Andes revealed that all of them carried root symptoms of this disease (Table 2). An analysis of the amount of infection of Caliverde was made on a 1-year-old field located at the same Experiment Station. Samples were dug every ten rows while criss-crossing the field and then walking down the edges. Cross sections of the roots were made a short distance below the crown. The degree of infection was rated from 0 to 5: 0 indicating no discoloration of the vascular tissues, 1 just barely perceptible greening, while 2, 3 and 4 were used for more intensive browning of the ring. A rating of 5 indicated extensive deep brown discoloration which extended inward through the root. Again, all plants showed some degree of infection. The distribution of intensity of disease in the different classes followed a normal curve (Table 3).

Though the disease syndrome in Chile is typical of alfalfa wilt reported elsewhere (2) more definite proof of its identity was necessary. Isolations were made from samples of roots that were brought into the laboratory from the various surveys. The roots were thoroughly washed, then cross sectioned and pieces of tissue from discolored areas placed on Burkholder's medium (1). Bacterial colonies were obtained, except in a few cases where rotting of the roots due to a fungus was apparent. The bacteria were then stained for Gram reaction. In 137 of the 138 samples, Gram-positive bacteria were isolated. One instance occurred in which a mixture of Gram-positive and Gram-negative organisms were isolated. Almost all of the Gram-positive isolates were short rods which seemed to

fit the originally published descriptions of Corynebacterium insidiosum (3). Furthermore, they were similar in size and shape to known cultures obtained from Dr. Ernest H. Stanford of Davis, California and the Madison, Wisconsin strain from Dr. A. Panella of the University of Perugia. The Chilean strain differed from the Wisconsin organism in the absence of a greyish green pigment when grown on potato dextrose agar. The Chilean isolates are being studied in more detail to determine their identity with C. insidiosum.

Further proof that these Gram-positive isolates are C. insidiosum and that they cause the Chilean wilt, was sought by applying Koch's postulates to this disease. The organisms were grown in liquid media for 6 days, centrifuged and then resuspended in water. Roots of 3-month-old alfalfa seedlings were cut while immersed in this suspension and allowed to remain there a few minutes. These seedlings were then replanted in sterile soil and cut back after 1 week's growth. After 4 months some plants were examined and Gram-positive bacteria similar to those used as inoculum were re-isolated. Root symptoms of the disease rarely appear so soon after inoculation; the roots of inoculated and control plants will be examined and further isolations made after 1 year.

From the results of this survey, it appears that the disease which is present in Chile is similar to bacterial wilt of alfalfa. Absolute evidence of the identity will depend on the results of studies now under way. The widespread distribution of the wilt is surprising for it has even been found in areas not previously sown with alfalfa such as Osorno, an area in which alfalfa is never grown by farmers. Nor would one have expected to find the wilt in old Inca valleys where there has been no introduction of new seed for hundreds of years. Its presence in most other areas is not surprising since seed is often introduced from elsewhere and the fine plant parts and dust might carry the bacteria along with the seed. Because most alfalfa is grown under irrigation, conditions are ideal for the rapid spread of a bacterial pathogen by the irrigation water.

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LABORATORY AND GREENHOUSE SCREENING OF VARIOUS FUNGICIDES FOR CONTROL OF RHIZOCTONIA DAMPING-OFF OF COTTON SEEDLINGS[1]

J. B. Sinclair[2]

Abstract

Some 17 fungicides, alone or in combination, were screened in the laboratory and greenhouse to test their ability to control Rhizoctonia solani Kuehn, the principal causal organism of damping-off of cotton seedlings. The greenhouse assays provided a better method for screening than did the cotton string technique used in the laboratory. The former may be used to predict how various fungicides will perform in the field. Those fungicides used alone showing the most promise were the omadine derivatives (2-pyridinethione 1-oxide; the zinc, manganese and disulfide derivatives), PCNB (pentachloronitrobenzene), captan (N-(trichloromethylthio)-4-cyclohexene-1, 2-dicarboximide) and nabam (disodium ethylenebis (dithiocarbamate)). The combined fungicide treatments showing the most promise were: captan in combination with either PCNB or the zinc salt of omadine; nabam in combination with mylone (tetrahydro-3, 5-dimethyl-2H-1, 3, 5-thiodiazine-2-thione) or zinc sulfate; and PCNB in combination with mylone.

INTRODUCTION

Cotton damping-off has been an important seedling disease of cotton since 1892 (1). This damping-off malady has been found in every cotton growing area of Louisiana and is the one disease that has caused, in recent years, the largest estimated loss of cotton in the South (5). The organism most frequently isolated from diseased seedlings has been Rhizoctonia solani Kuehn and recent reports show that species of Pythium and Fusarium may be important pathogens in a damping-off complex (4, 8).

Screening fungicides for control of cotton damping-off, under field conditions, is difficult because of the erratic occurrence of the disease from season to season in any one location (2). Screening fungicides in the laboratory and greenhouse, where more controlled conditions are available, might give basic information as to the effect of any single fungicide on one of the causal organisms, R. solani, and the extent of its phytotoxicity on cotton seedlings. This preliminary screening eliminates certain fungicides and only those showing the most promise would be tested in the field. Such a program has been started and a preliminary report of the first results is given. These data will be used for selections of fungicides for further screening under field conditions in Louisiana.

The fungicides tested were: omadine derivatives (2-pyridinethione 1-oxide; the zinc, manganese and disulfide derivatives); PCNB (pentachloronitrobenzene); captan (N-(trichloromethylthio)-4-cyclohexene-1, 2-dicarboximide); nabam (disodium ethylenebis(dithiocarbamate)); mylone (Tetrahydor-3, 5-dimethyl-2H-1, 3, 5-thiadiazine-2-thione); vapam (sodium-N-methyldithiocarbamate); panogen 221 (methyl mercury dicyandiamide); coromerc (N-phenylmercuriethylenediamine); BB/360/302 (phenylmercury dimethyldithiocarbamate); compounds MN-1-9

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Appreciation is expressed to the following chemical companies for providing samples of the fungicides indicated: Olin-Mathieson Chemical Corp. (omadine derivatives and PCNB (Terraclor)); Stauffer Chemical Co. (captan and vapam); Chemagro Corp. (cmpd. C-272); Carbide and Carbon Chemical Co. (Crag 974 (Mylone)); Monsanto Chemical Co. (cmpds. CP-376 and Z-2346); Rohm and Haas Co. (nabam (Dithane D-14) and zinc sulfate); Mallinckrodt Chemical Corp. (cmpds. MN-1-9 and MN-3-9); Corona Chemical Co. (coromerc); Chipman Chemical Co. (cmpd. BB/360/302); General Chemical Co. (exp. fungicide #8); and Panogen, Inc. (panogen 221).

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(27 percent ammonium salt of pelargonic acid), MN-3-9 (35 percent emulsifiable concentrated pelargonic acid), C-272, CP-376, Z-2346 and experimental fungicide #8.

LABORATORY EXPERIMENTS

Using a modification of the cotton string technique (3), the 17 fungicides were tested for their ability to inhibit the growth, in vitro, of an isolate of Rhizoctonia solani. The fungus was isolated from diseased cotton seedlings collected in the Mississippi River Delta near Roosevelt, Louisiana. Three concentrations of each fungicide were used: 1,000, 5,000 and 10,000 ppm of the active ingredient. Three separate series were made with each series repeated at least twice and each treatment within a series was replicated three times. Between 3 and 5 days after treatment, measurements of mycelial growth were made and recorded in centimeters. A total of three measurements was taken for each individual replicate and an average determined. The data were statistically analyzed.

It could be determined from these experiments which fungicides would actually inhibit growth of the organism in vitro and the most promising would be used for further screening in the greenhouse. Greenhouse tests would determine the effect of the fungicide on R. solani in soil and the extent of phytotoxicity to cotton seedlings.

In order to check the efficiency of the cotton string technique as a screening procedure, all fungicides tested in the laboratory were also screened in the greenhouse, except as indicated.

LABORATORY RESULTS

Most of the fungicides tested using the cotton string technique gave partial or complete inhibition of growth of the isolate of R. solani used when compared with nontreated checks (Table 1). Differences were significantly lower at the .01 level for all fungicides except mylone (1,000 ppm) and compound CP-376 (1,000, 5,000 and 10,000 ppm) in series A-2, which were significantly higher at the .01 level. Fungicide compound Z-2346 (1,000 ppm) in series A-2, nabam (1,000 ppm) in series B-2, PCNB (5,000 ppm) in series C-1 and compound CP-376 (10,000 ppm) in series C-2 showed no significant differences over the checks. All the means in series B-1 and compound CP-376 (5,000 ppm) in series C-1 were significantly lower at the .05 level.

There was a tendency for increased inhibition as the concentration of any fungicide was increased, except with vapam in series B-2, PCNB in series A-1 and C-1, and captan in series C-1.

In general, results showed that the fungicides either partially or completely inhibited the growth of the organism. All fungicides at 10,000 ppm completely inhibited the growth of the organism except PCNB, which showed partial inhibition. Vapam and compounds CP-376 and Z-2346 were erratic in their performance.

GREENHOUSE EXPERIMENTS

All fungicides screened in the laboratory were tested in the greenhouse except coromerc, BB/360/302 and experimental fungicide #8. The greenhouse tests were run using unsterilized field soil inoculated with the same isolate of R. solani used in the laboratory screening. The organism was grown on potato-sucrose broth until a thick mycelial mat with sclerotia was produced in about 7 to 14 days. The broth was decanted off and the mat and sclerotia mixed in a Waring Blendor with 200 cc of distilled water. This inoculum was mixed with the soil in greenhouse flats about 2 weeks before planting. Preliminary tests showed that a 2-week interval gave a more uniform disease index than did flats planted 1 week after inoculation. Single fungicides were applied at the time of sowing at a rate of 5 pounds per acre for the wettable powders and 4 quarts per acre for the liquids as an in-the-furrow treatment. Combined fungicides were applied at equivalent rates. Inoculated-nontreated and noninoculated-nontreated flats served as controls. All treatments were replicated seven times with 50 Deltapine 15 cotton seeds sowed per replicate. Stand counts and the number of seedlings showing damping-off symptoms were taken approximately 2 weeks after the sowing and treatment date (Table 2). Greenhouse treatments were maintained as close as possible to 70° F (8).

Table 1. The relative inhibition of growth in vitro of an isolate of Rhizoctonia solani by various fungicides at three concentrations using the cotton string method of assay.

Fungicide	Concentration 1,000 ppm	Treatment means in cm for series and run indicated					
		A		B		C	
		1	2	1	2	1	2
Omadine, disulfide	1	0.3	0	0.5	0	0	2.0
	5	0	0	0.1	0	0	0
	10	0	0	0	0	0	0
Omadine, manganese salt	1	1.4	0	0	0	0	1.8
	5	0	0	0	0	0	0
	10	0	0	0	0	0	0
Omadine, zinc salt	1	0	0	0	-[a]	0	0
	5	0	0	0	-	0	0
	10	0	0	0	-	0	0
PCNB	1	1.5	0	1.8	2.8	3.9	4.0
	5	3.5	0	1.0	1.4	4.8	1.9
	10	1.1	0	0.8	1.7	2.4	0.7
Compound C-272	1	0	0	0.6	0	0	0
	5	0	0	0	0	0	0
	10	0	0	0	0	0	0
Captan	1	2.6	2.9	0	0	0	0
	5	0.3	0	0	0	1.4	0
	10	0	0	0	0	0	0
Mylone	1	3.2	6.0	0.6	2.1	0	0
	5	0	0	0	0	0	0
	10	0	0	0	0	0	0
Compound CP-376	1	5.1	6.9	-[a]	0	0	0
	5	4.3	6.6	-	0	4.6	0
	10	5.0	6.5	-	0	5.5	5.2
Compound Z-2346	1	4.8	5.3	-	-	0	0.7
	5	4.1	3.4	-	-	1.9	0
	10	3.2	2.6	-	-	2.3	0
Compound MN-3-9	1	2.7	1.5	0	1.2	1.8	0
	5	0	0.3	0	0	0	0
	10	0	0	0	0	0	0
Compound MN-1-9	1	2.4	1.0	0	0	0	0
	5	0	0.6	0	0	0	0
	10	0	0	0	0	0	0
Nabam	1	0	0	0	5.4	1.8	0
	5	0	0	0	0	0	0
	10	0	0	0	0	0	0
Coromerc	1	0	0	-	-	-[a]	-[a]
	5	0	0	-	-	-	-
	10	0	0	-	-	-	-
BB/360/302	1	2.9	2.0	-	-	-	-
	5	0	0	-	-	-	-
	10	0	0	-	-	-	-
Vapam	1	-[a]	-[a]	0	0	0	0
	5	-	-	0	0	0	0
	10	-	-	0	1.1	0	0
Panogen 221	1	-	-	0	0	0	0
	5	-	-	0	0	0	0
	10	-	-	0	0	0	0
Exp. fungicide #8	1	0	0	-	-	-	-
	5	0	0	-	-	-	-
	10	0	0	-	-	-	-
Untreated check	-	6.2	5.2	4.8	5.7	5.0	5.4
L. S. D. 5%		.35	.29	.09	.23	.29	.19
1%		.47	.39	ns	.30	.39	.26

[a]Not included in run.

Table 2. Treatment means for total stand count and diseased cotton seedlings grown in non-sterilized soil inoculated with an isolate of Rhizoctonia solani under greenhouse conditions.

Treatment[a]	Trial 1		Trial 2		Trial 3	
	Stand	Diseased	Stand	Diseased	Stand	Diseased
Omadine, disulfide	33.6	7.6	27.7	4.6	24.9	17.1
Omadine, manganese	39.4	9.4	27.9	14.1	30.8	21.1
Omadine, zinc salt	38.9	5.7	26.4	9.6	22.5	17.1
PCNB	33.6	2.1	33.3	6.9	---[c]	---[c]
Captan	34.3	6.9	27.9	20.0	29.4	22.1
Nabam	30.9	4.9	30.0	16.9	33.7	21.1
Mylone	24.7	13.1	30.7	4.1	6.3	2.6
Panogen 221	32.9	25.1	29.7	14.4	--	--
Compound C-272	33.1	26.4	---[c]	---[c]	--	--
Compound CP-376	28.6	16.3	--	--	--	--
Compound Z-2346	---[b]	---[b]	--	--	--	--
Compound MN-1-9	19.7	14.0	18.6	18.4	--	--
Compound MN-3-9	36.9	12.6	29.7	21.4	18.3	18.3
Vapam	1.3	---[b]	26.7	14.9	16.4	13.4
Captan + PCNB	28.1	4.4	31.0	8.3	30.3	10.6
Captan + omadine zinc salt	33.4	11.3	32.0	5.0	22.6	20.4
Captan + Compound MN-3-9	---[c]	---[c]	30.1	15.7	--	--
Captan + nabam	--	--	--	--	25.3	22.3
Nabam + omadine manganese salt	--	--	30.0	5.9	33.3	20.1
Nabam + omadine zinc salt	--	--	29.9	7.9	26.3	13.6
Nabam + omadine disulfide	--	--	--	--	28.4	24.8
Nabam + zinc sulfate	--	--	30.7	15.0	31.9	26.3
Nabam + mylone	--	--	--	--	26.7	26.7
Mylone + PCNB	--	--	--	--	30.8	12.4
Nontreated-inoculated check	2.17	21.4	27.6	21.7	18.3	18.6
Nontreated-noninoculated check	38.6	0	32.0	0	32.7	0
L. S. D. 5%	2.4	1.2	1.0	1.4	1.1	1.4
1%	3.2	1.6	1.3	1.6	1.5	1.9

[a]All treatments at 5 pounds per acre for wettable powders and 4 quarts per acre for liquids, or equivalents when in combination.
[b]Extremely phytotoxic.
[c]Not included in run.

GREENHOUSE RESULTS

The stand count data gave information on the control of pre- and post-emergence damping-off, as well as the extent to which the various chemicals were phytotoxic to germinating cotton seed.

Most of the treatments for stand count in the three trials were significantly lower at the .01 level when compared with the nontreated-noninoculated control, except for the following: In trial 1 the manganese and zinc salts of omadine and compound MN-3-9 showed no significant differences, also the combinations of captan plus PCNB and captan plus zinc salt of omadine in trial 2, also in trial 3 where nabam was used alone or in combination with the manganese salt of omadine or zinc sulfate. In trial 1 vapam and compound Z-2346 were severely phytotoxic to the extent that few, if any, seedlings emerged. In trial 2, PCNB showed a stand significantly higher at the .05 level, while the stands for mylone and nabam plus zinc sulfate were significantly lower at the .05 level. In no case did the noninoculated-nontreated control plants show damping-off symptoms.

Most stand count treatments in the three trials gave a significantly higher mean at the .01 level when compared with the inoculated-nontreated control, except for the following: In trial 1 mylone was significantly higher at the .05 level. There were no significant differences shown by compound MN-1-9 in trial 1; in trial 2 by the disulfide derivative of omadine, the manganese salt of omadine, captan, or vapam; or by compound MN-3-9 in trial 3. The zinc salt of omadine was significantly lower at the .05 level in trial 2, and compounds significantly lower at the .01 level were vapam in trial 1, compound MN-1-9 in trial 2, and mylone and vapam in trial 3.

The amount of disease control or post-emergence damping-off varied with each fungicide, but there was a significantly lower disease count at the .01 level for most treatments when compared with the inoculated-nontreated control. In trial 1 this was true except for panogen 221 and compound C-272, both of which showed a significantly higher number of diseased plants at the .01 level; and in trial 2 compound MN-3-9 showed no significant difference. Trial 3 showed a significantly higher disease count for the manganese salt of omadine, captan, nabam, captan plus the zinc salt of omadine; and nabam in combination with: captan, the manganese salt of omadine, the disulfide derivative of omadine, zinc sulfate and mylone. The compound MN-3-9 showed no significant difference. The inoculated-nontreated control plants in all cases had almost 100 percent infection 2 weeks after planting. The inoculated-nontreated control of trial 3 had some pre-emergence damping-off and this accounts for the lower mean.

SUMMARY AND CONCLUSIONS

Laboratory screening of fungicides for their inhibition of growth of Rhizoctonia solani in vitro was not sensitive enough to predict their greenhouse performance. There was a marked tendency for increased inhibition of growth as the concentration of the fungicides was increased. All 17 fungicides tested gave either complete or partial inhibition of the organism and a few were erratic in their action.

The fact that most treatment means for stands in the greenhouse gave significantly higher readings at the .01 level over the inoculated-nontreated control indicates that these fungicides exhibited some control of pre-emergence damping-off. Most of the treatment means for stands, when compared with the noninoculated-nontreated control, were significantly lower at the .01 level, indicating that pre-emergence damping-off was not completely controlled or that all these chemicals might exhibit some phytotoxicity. If the latter is the case, then any fungicide should be evaluated as to the extent to which it is toxic to cotton seed. It is obvious that any chemical that reduces germination or stand significantly is of little or no value. Such fungicides in this experiment were compound Z-2346 and, to a certain extent, mylone, vapam and compounds CP-376 and MN-1-9.

Even though some disease treatment means show a significantly lower amount of disease at the .01 level, the actual control of post-emergence damping-off is not enough to be of practical value. The ideal fungicide would give complete control, so that those chemicals that show the least amount of disease should be considered above those giving moderate control. Also, both emergence data and disease control must be considered for any treatment since a low stand count would give a low disease reading. This was exhibited by vapam, mylone, and compounds MN-1-9 and MN-3-9.

Those single chemical treatments that exhibited the most promising control, as shown in the greenhouse tests, were the omadine derivatives, PCNB, captan and nabam. Combination

treatments showing the most promise were: captan in combination with PCNB, and the zinc salt of omadine; nabam in combination with zinc sulfate and mylone and mylone plus PCNB.

Greenhouse assays on cotton seedlings offered a better method for screening than did the cotton string technique in the laboratory and may be worth while in predicting how various fungicides, alone or in combination, will perform in the field. Greenhouse results compare favorably with field results of Neal (6, 7) and of Whitehead and Brown (9).

This report does not constitute a recommendation. Results from these experiments are being tested further in the field and additional greenhouse trials are in progress.

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TREE LEAF DISEASES IN ILLINOIS DURING 1957

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There was a high incidence of tree leaf diseases in Illinois during 1957, because of excessive precipitation and mild temperatures during the spring and early summer. The findings reported herein are based on leaf specimens collected in the field and received by this laboratory for diagnosis.

A study of the weather reports for Illinois during the period April through July, 1957, showed that in April the average rainfall for the State was 6.79 in., an amount 86 percent greater than the long-term mean for this month. During May, June, and July, the average precipitation was 5.89, 5.86, and 4.51 inches, respectively, representing an increase over the long-term mean of 46 percent, 34 percent, and 39 percent. For these same months the average monthly temperatures were near or slightly below the long-term means. In April sub-normal temperatures prevailed through the first half of the month with below freezing temperatures every day during April 11 to 14. Temperatures rose enough in the latter half of the month so that the average for April was near the long-term mean. During July there was a lack of excessive heat, very few weather stations reporting temperatures as high as 100° F.

The wet, cool spring was very favorable for the juniper rust diseases, including cedar-quince, cedar-apple, and cedar-hawthorn rust. In the Natural History Survey Tree Plot the spore horns on the juniper galls were gelatinous, actively producing spores, from mid-April until the middle of May. During this period rain fell so frequently that it was impossible to keep a continuous cover of a protective fungicide on the hawthorn leaves. Infection was so severe that even sprayed trees began to lose their leaves by the end of May.

Anthracnose on sycamore, caused by Gnomonia veneta, usually widespread in Illinois, was again found in abundance in the State. This year, as was the case last year, there was very little early leaf blight. Most of the infection developed as a late-season leaf blight. Late-season leaf blight does not cause defoliation unless infection is very severe. Anthracnose on white oak, also caused by G. veneta, was more severe in the State than had been observed since 1945[1]. Anthracnose was also found on leaves of maple, hickory, buckeye, and elm.

Leaf spot fungi encountered on trees in Illinois this year are listed in Table 1.

Table 1. Fungi identified as causing tree leaf diseases in Illinois during 1957.

Common name of host	Scientific name of host	Scientific name of fungus
Ash	Fraxinus americanum L.	Phyllosticta fraxinicola (Currey) Ell. & Ev.
Box elder	Acer negundo L.	Cylindrosporium sp. Gloeosporium apocryptum Ell. & Ev. Phleospora aceris (Lib.) Sacc.
Buckeye	Aesculus glabra Willd.	Guignardia aesculi (Pk.) V. B. Stewart
Horse-chestnut	A. hippocastanum L	Guignardia aesculi (Pk.) V. B. Stewart
Cedar	Juniperus virginiana L.	Gymnosporangium globosum Farl. G. juniperi-virginianae Schw.
Cherry	Prunus spp.[a]	Cercospora sp. Podosphaera oxyacanthae (DC) D By.
Crab apple	Malus angustifolia (Ait.) Michx.	Gymnosporangium juniperi-virginianae Schw. Venturia inaequalis (Cke.) Wint.

[1] Carter, J. C. 1945. Anthracnose of sycamore and oak in Illinois. Plant Dis. Reptr. 29: 535.

Table 1. (continued)

Common name of host	Scientific name of host	Scientific name of fungus
Elm	Ulmus americanum L	Fumago sp. Gloeosporium ulmicolum Miles Gnomonia ulmea (Schw. ex Fr.) Thuem.
Hawthorn	Crataegus spp.[a]	Fabraea maculata Atk. Gymnosporangium globosum Farl. G. juniperi-virginianae Schw.
Hickory	Carya ovata K. Koch	Gnomonia caryae Wolf
Holly	Ilex sp.[a]	Phyllosticta sp.
Magnolia	Magnolia soulangeana Soul.	Microsphaera alni DC ex Winter
Maple	Acer spp.[a]	Gloeosporium apocryptum Ell. & Ev. Phyllosticta sp. Rhytisma acerinum (Pers.) ex Fr.
Oak	Quercus alba L.	Actinopelta dryina (Sacc.) Hoehn Gnomonia veneta (Sacc. & Speg.) Kleb.
	Q. borealis Michx.	Marssonina quercina (Wint.) Lentz Microsphaera alni DC ex Wint.
	Q. macrocarpa Michx.	Actinopelta dryina (Sacc.) Hoehn Gnomonia veneta (Sacc. & Speg.) Kleb.
	Q. palustris Muench.	Gloeosporium quercinum West. Marssonina quercina (Wint.) Lentz Phyllactinia corylea Pers. ex Karst. Taphrina caerulescens (Mont. & Deam.) Tal.
	Q. velutina Lam.	Actinopelta dryina (Sacc.) Hoehn Marssonina quercina (Wint.) Lentz
	Quercus sp.[a]	Macrophoma sp.
Pine	Pinus resinosa Ait.	Coleosporium solidaginis (Schw.) Thuem.
Sumac	Rhus glabra L.	Oidium sp.
Sycamore	Platanus occidentalis L.	Gnomonia veneta (Sacc. & Speg.) Kleb.
Wafer ash	Ptelea trifoliata L.	Cercospora afflata Wint.
Walnut	Juglans nigra L.	Marssonina juglandis (Lib.) Magn.

[a]Not identified to species because of insufficient material.

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VERTICILLIUM WILT IN KANSAS[1]

Clark T. Rogerson[2]

Summary

Prior reports have indicated the presence of Verticillium wilt in Kansas on elm and peony. The host range in Kansas is extended to include western catalpa, Moline elm, redbud, Russian olive, and turnip. The two last-named plants are first report records as hosts for Verticillium albo-atrum Reinke & Berth.

Verticillium wilt rarely has been reported from Kansas. R. P. White reported that wilt of peony (Paeonia spp.) caused by Verticillium albo-atrum Reinke & Berth, was present in one nursery at Topeka, Shawnee County, during 1923. This was published in a report compiled by G. H. Martin (5) in 1925 and appears to be the first record of the disease in Kansas. In 1925 R. P. White reported wilt of peony from Atchison, Leavenworth, Wyandotte, and Shawnee Counties. This was published by G. H. Martin (6) in 1926. These reports apparently are the basis for the records of Bartholomew (1) in 1927 (Verticillium albo-atrum listed for Kansas without designation of host), of Weiss (8) in 1948 (V. albo-atrum on Paeonia albiflora Pall. and P. officinalis L.), of Weiss and O'Brien (10) in 1953 (V. albo-atrum on Paeonia lactiflora and P. officinalis) and the more recent compilation by Engelhard (2) in 1957 (V. albo-atrum on Paeonia lactiflora and P. officinalis).

An additional record is the report of Kelsheimer and May (4) in 1940, who reported that Verticillium, without designation of species, was isolated from one elm twig collected in Kansas during 1938 and submitted to the Dutch elm disease control office, Bureau of Plant Industry, United States Department of Agriculture.

Thus, prior to the present report, Verticillium wilt had been reported from Kansas on only two hosts, namely, elm and peony.

In routine isolations from diseased plants in Kansas over the past 4 years, 1954-1957, Verticillium was obtained from several hosts, showing wilt symptoms, which were collected in widely scattered localities within the State. This suggests that Verticillium wilt is not only well established in Kansas but can attack several important plants and thus is a potential threat to many other economically important hosts.

Table 1 indicates the records which are authenticated by isolation of the causal organism. All isolations were made from plants showing wilt symptoms and dark vascular tissue.

Additional observations on these records can be indicated. Isolates of Verticillium were obtained from recently wilted branches of two catalpa trees in Manhattan. Several dead branches indicated that the disease had been present for several years. Catalpa trees showing wilt symptoms similar to the two trees at Manhattan, from which Verticillium was isolated, were observed at Goodland, Sherman County, near the western border of Kansas; at Concordia, Cloud County, in north-central Kansas; at Topeka, Shawnee County, in east-central Kansas; at Hiawatha, Brown County, in northeastern Kansas; and in Atchison County, at the eastern border of Kansas. This suggests that on catalpa the disease is present across the entire State, at least in the northern part. The Moline elm tree at Norton had been planted for two years and all the leaves were in a wilted condition. This apparently is the second report of the disease on Moline elm in the United States. The only report given by Engelhard (2) on Moline elm is from Illinois. The disease is well established in two commercial peony fields at Topeka and one in Wichita. Evidently the disease has persisted in the Topeka area since White's first report in 1923. The record on redbud appears to constitute a second State record in the United States, the other record (2) being from Illinois. Weiss (9) listed Verticillium sp. on Russian olive in Washington. The Kansas record is the first for Verticillium albo-atrum on Russian olive. The record for turnip apparently is the first on that host.

[1]Contribution No. 508, Serial No. 656, Department of Botany and Plant Pathology, Kansas Agricultural Experiment Station, Manhattan, Kansas.

[2]Associate Mycologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

Table 1. Verticillium isolates from Kansas, 1954-1957.

Host	Locality	Date
Brassica rapa L., turnip	Salina, Saline Co.	October, 1954
Catalpa speciosa Warder, western catalpa	Manhattan, Riley Co.	June, 1955
Cercis canadensis L., redbud	Marysville, Marshall Co.	July, 1955
Elaeagnus angustifolia L., Russian olive	Jetmore, Hodgeman Co.	June, 1955
Paeonia sp., peony	Topeka, Shawnee Co.	June, 1956
Paeonia sp., peony	Topeka, Shawnee Co.	June, 1957
Paeonia sp., peony	Wichita, Sedgwick Co.	June, 1956
Ulmus americana L., Moline elm	Norton, Norton Co.	July, 1957

Following the interpretation of Rudolph (7) and many American plant pathologists, all of the isolates of Verticillium listed in Table 1 would be designated as Verticillium albo-atrum Reinke & Berthold (including Verticillium dahliae Kleb.). However, if the species concepts of Isaac (3) are accepted, the isolates would be referred to as Verticillium dahliae Kleb. The isolates grew well on potato dextrose agar medium, readily produced microsclerotia, and grew at 30° C.

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9. WEISS, FREEMAN. 1950. Index of plant diseases in the United States, Part II. U. S. Dept. Agr. Plant Disease Special Publication 1: (page 302).
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DEPARTMENT OF BOTANY AND PLANT PATHOLOGY, KANSAS STATE COLLEGE, MANHATTAN, KANSAS

RECORDS OF CITRUS CANKER AND SWEETPOTATO STEM AND FOLIAGE SCAB IN MICRONESIA

Anna E. Jenkins[1] and F. Raymond Fosberg[2]

Among botanical collections made in 1946 under the auspices of the U. S. Commercial Company Economic Survey of Micronesia is an assemblage of specimens gathered to show the diseased condition of some of the plants. A recent review of this material as held with the whole collection of Micronesian plants awaiting distribution in the United States National Herbarium reveals that the diseases of citrus (Citrus spp.) and sweetpotato (Ipomoea batatas) represented are chiefly citrus canker (Xanthomonas citri (Hasse) Dows.) and sweetpotato stem and foliage scab (Elsinoë batatas Viégas & Jenkins).

Citrus Canker:

The five specimens of citrus canker (Fosberg 24502, R. E. Oakley 10, 17, 23, 26), supplemented by specimens (Maehler N-490, R. G. Oakley (no number), M. M. Ross Hawaii 4854) or published records (6, 7) of the United States Plant Quarantine Branch are tabulated below:

Kind of Citrus and part affected	Locality	Date	Collector
	MARIANA ISLANDS		
Citrus sp., leaves & stems	Guam, Talofofo	June 16, 1946	R. G. Oakley 17
C. aurantifolia	Rota Island	1953 (6, p. 61)	
C. aurantifolia	Guam	1954 (7, p. 56)	
	CAROLINE ISLANDS		
C. aurantifolia, leaves	Truk, Udot Island	May 25, 1956	F. R. Fosberg 24502
Citrus sp., leaf, stem & fruit	Truk, Moen Island	June 1, 1946	R. G. Oakley 10
Citrus sp., leaves	Palau, Korror Island	July 19, 1946	R. G. Oakley 23
Citrus sp., leaf & stem	Ponape, Paliker Island	Aug. 8, 1946	R. G. Oakley 26
Citrus sp., rind	Palau, Babelthuat Island	July 22, 1946	R. G. Oakley*
C. aurantifolia, leaf	Dublon Island	Feb. 11, 1948	K. L. Maehler N-490
C. aurantifolia, leaf	Truk, Moen Island	Jan. 6-15, 1949	M. M. Ross Hawaii 4854
C. aurantifolia	Palau, Korror Island	1953 (6, p. 61)	
C. limonia	Truk	1953 (6, p. 61)	

*A note accompanying this specimen, prepared by W. S. Fields of the Plant Quarantine Division, reads essentially as follows: "R. G. Oakley states that the tree was large, growing in shade. The fruit, medium size, bitter tasting, like a tangerine, but skin like an orange. Fruit, leaves and twigs reported as 100% infected. Dr. F. R. Fosberg who accompanied Mr. Oakley was unable to identify the species."

All eight specimens listed above are abundantly attacked by this disease, which according to Dowson (2) is often spread by cuttings. The Commonwealth Mycological Institute's distribution map of citrus canker (1) dated 1942, shows the wide Asiatic distribution of this bacterial malady. The sources of reference, however, do not include Micronesia.

[1]R. F. D. 3, Walton, New York.
[2]Falls Church, Virginia.

Sweetpotato Stem and Foliage Scab:

The three specimens of sweetpotato stem and foliage scab collected during the Economic Survey of Micronesia are from the Caroline Islands as follows:

Locality	Date (1946)	Collector
Truk, Fefan Island	May 27	F. R. Fosberg 24506
Yap Island	July 13	R. G. Oakley 20
Palau, Korror Island	July 23	R. G. Oakley 24

These three specimens (Fosberg 24506 previously reported (4)) are illustrative of how severely this disease may attack, with consequent stunting of the terminal growth as was noted by Japanese plant pathologists (cf. Jenkins & Viégas 3). In the Mariana Islands the scab was discovered in Guam, 1937-1939, by R. G. Oakley (4). The two references just cited are included in Sachet and Fosberg's (5) bibliography of Micronesian botany.

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7. UNITED STATES DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE, PLANT QUARANTINE BRANCH. 1955. List of intercepted pests, 1954. 61 p.

UNUSUAL RECORDS AND OTHER BRIEF NOTES ON PLANT DISEASES

SCLEROTINIA ON STRAWBERRY FRUIT IN NORTHWEST WASHINGTON

By D. M. McLean[1]

An unusual occurrence of Sclerotinia sclerotiorum (Lib.) D By. on ripening strawberry fruit was observed in experiment station plots during 1957. Dense white mycelium containing sclerotia of S. sclerotiorum was pronounced on the surface of the infected fruit (Fig. 1). Invasion apparently was from the calyx end. S. sclerotiorum is a common pathogen of various crop plants in northwestern Washington and has been reported elsewhere as causing a crown rot of strawberry. This is the first report of the fungus on strawberry fruit in Washington.

FIGURE 1. Strawberry infected by Sclerotinia sclerotiorum, showing prominent sclerotia produced by the fungus.

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[1]Associate Plant Pathologist, Agricultural Research Service, Crops Research Division, Northwestern Washington Agricultural Experiment Station, Mount Vernon, Washington.

NUT DISEASES IN OREGON IN 1957

By P. W. Miller

WALNUT DISEASES: Walnut blight (Xanthomonas juglandis (Pierce) Dowson) was widely distributed, causing greater economic loss than in the preceding three years. The increase in severity of the disease was due to "heavy"-rain periods in most localities during the critical period for infection. Nut losses from this disease in non-sprayed orchards varied, according to the locality, from 10 to 50 percent.

Mushroom root rot (Armillaria mellea Vahl. ex. Fr.) caused the decline and death of a limited number of Persian walnut trees (Juglans regia) grafted on Hinds black walnut (J. hindsii) and Persian walnut rootstocks.

Leaf scorch (non-parasitic) was prevalent in western Oregon, occurring in most Persian walnut orchards in that part of the State. However, it was generally not as prevalent or as severe as in 1955 and 1956.

Blackline of grafted walnuts (non-parasitic) occurred in practically all walnut-growing districts in the State. It was found only on Persian walnut trees grafted on black walnut rootstocks (J. hindsii or J. nigra) or on hybrids of these and other species of walnut. Not a single case of blackline was found in Persian walnuts grafted on Persian walnut rootstocks. Blackline occurred in orchards located on practically all soil series in western Oregon, but was more prevalent on the Olympic soil series than on any other.

A crown and collar rot of undetermined cause was found affecting a limited number of

Persian walnuts grafted on Hinds black walnut rootstocks and some Persian seedling walnuts.

FILBERT DISEASES: Bacterial blight (Xanthomonas corylina (P. W. Miller et al.) Dowson) was widely distributed in filbert orchards in western Oregon in 1957.

Powdery mildew (Phyllactinia corylea Karst.) occurred in numerous filbert orchards in western Oregon. However, it was of little or no economic importance as it did not make its appearance until toward the end of the season and the leaves persisted on the trees until the time of normal leaf fall.

Brown stain (non-parasitic) was present in limited amounts, but crop losses from this disorder were negligible.

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ROOT-LESION NEMATODE RECOVERED FROM EASTERN REDCEDAR AT HALSEY, NEBRASKA

By Fields E. Caveness[1]

One- and two-year seedlings of eastern redcedar, Juniperus virginiana L., from the Bessey Nursery in the Nebraska National Forest at Halsey, Nebraska were heavily infected by the root-lesion nematode, Pratylenchus penetrans (Cobb, 1917) Sher & Allen, 1953. Infected two-year seedlings were much reduced in height, ranging from 6 to 8 cm compared with 31 to 37 cm for unaffected two-year seedlings. The population density was 100 nematodes per quart of soil, with 400 nematodes recovered from 0.7 gram of root tissue after 16 hours in a Baermann funnel. Two-year-old seedlings of Ponderosa pine, Pinus ponderosa Laws., were found to be free of root-lesion nematodes.

The samples were collected by B. H. Wilford and R. H. Nagel, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

BEET SUGAR DEVELOPMENT FOUNDATION, FORT COLLINS, COLORADO

[1]Nematologist, Beet Sugar Development Foundation.

CLADOSPORIUM FULVUM ON FIELD GROWN TOMATOES IN CONNECTICUT

By Saul Rich

Leaf Mold, caused by Cladosporium fulvum, has not been reported on tomatoes in Connecticut for many years. Clinton[1], who considered it to be primarily a disease of greenhouse tomatoes, reported that in Connecticut it "was first mentioned by Thaxter in 1889, about six years after its first discovery, and again in 1890, both reports being on out of doors tomatoes."

This year, plots of Sioux tomatoes were planted at the Mt. Carmel Farm on a piece of land which had not been in tomatoes for at least 25 years. The planting was at the bottom of a small valley and was surrounded on three sides by woods. The area has been a low, marshy spot in past years, but during the very dry summer of 1957, it just retained sufficient moisture for good plant growth. The plants were set out on June 19, and the disease was first noticed on August 8. Eventually, about 80 percent of the plants showed some spotting, but no single plant was seriously damaged. The disease did not appear on plants of this same seeding planted in the greenhouse, or at another area of the farm where there was good air drainage.

THE CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

[1]Clinton, G. P. 1934. Plant pest handbook for Connecticut. II. Diseases and injuries, Connecticut Agricultural Experiment Station Bulletin 358: 153-329.

FIELD INFECTION OF RADISH ROOTS WITH PERONOSPORA PARASITICA

By Saul Rich

Red Globe type radish roots showed infections of Peronospora parasitica in the field in Connecticut this year. In spite of the very dry summer, a few infections showed up early and were later spread by irrigation. The losses in the second planting, with the beginning of cooler weather, were as high as 75 percent of the radishes harvested on some farms.

The leaf symptoms consisted of irregular, yellow spots which produced white sporangiophores and sporangia on the under side of leaf after wet, cool weather. Considering the

amount of root infection, the leaves were in surprisingly good condition.

The root symptoms were like those described by Ramsey, et al. [1]: black spotting and discoloration at the stem end, usually superficial but occasionally extending into the center of the root. The discolored areas remained firm, even after prolonged storage. Peronospora parasitica sporulated readily from the cut surface of discolored roots when they were held in a moist chamber at 70° F for 1 to 2 days. Typical club-like branched haustoria were present in the infected tissue.

CONNECTICUT AGRICULTURAL EXPERIMENT STATION, NEW HAVEN, CONNECTICUT

[1]Ramsey, G. B., M. A. Smith, and W. R. Wright. 1954. Peronospora in radish roots. Phytopathology 44: 384-385.

CORRECTIONS

REPORTER, October issue (Vol. 41, No. 10), page 879: In Table 1, under "Materials", the last three items at the bottom should be "Agristrep plus TBCS", instead of "Agrimycin plus TBCS".

REPORTER, November issue (Vol. 41, No. 11), page 943: Reference No. 1 should read:

1. DEMAREE, J. B. 1945. Rhizoctonia bud rot of strawberry plants. Phytopathology 35: 710-713.

(IN THIS ISSUE Continued).

BLAIR H. MacNEILL reports that Colletotrichum atramentarium has recently been found to be the cause of a wilt of field tomatoes in Ontario, page 1032.

SAUL RICH tested griseofulvin, lithium salts, and zinc glass frit for the control of club root of cabbage, page 1033.

WALTER H. BURKHOLDER concludes that occurrence of rust on pea beans grown for dry shelled beans in New York is advantageous rather than harmful, page 1036.

IAN FORBES, Jr., et al. report resistance to gray leaf spot in some strains of blue lupine, and describe an inoculation technique that should be helpful in developing resistant varieties, page 1037.

Bacterial organisms in soybean leaves kept in cold storage remain viable and virulent for several years, according to DONALD W. CHAMBERLAIN, page 1039.

DAVID GOTTLIEB et al. report observations on the occurrence and identity of a bacterial wilt of alfalfa in Chile, page 1041.

J. B. SINCLAIR gives results of screening tests with various fungicides for control of Rhizoctonia damping-off of cotton seedlings, page 1045.

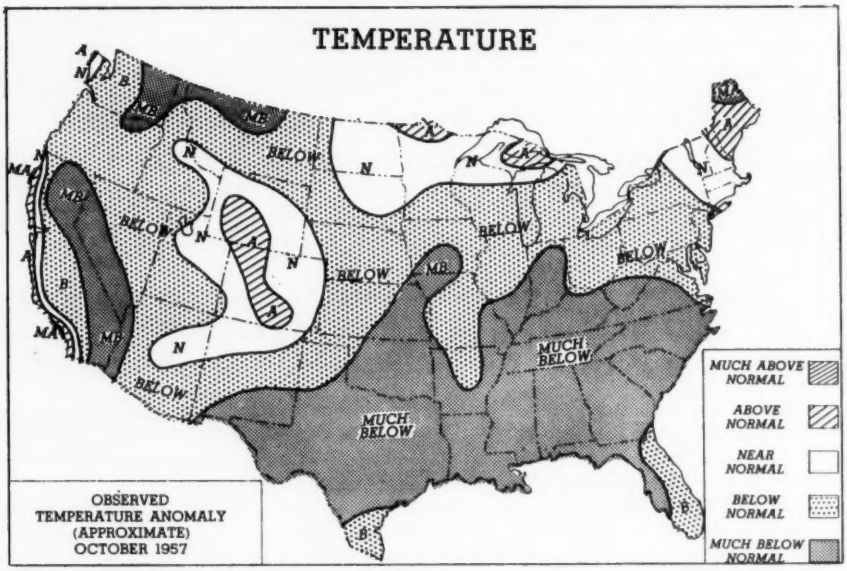
Weather was conducive to increased prevalence of leaf diseases of trees in Illinois this year, according to J. M. FERRIS et al., page 1051.

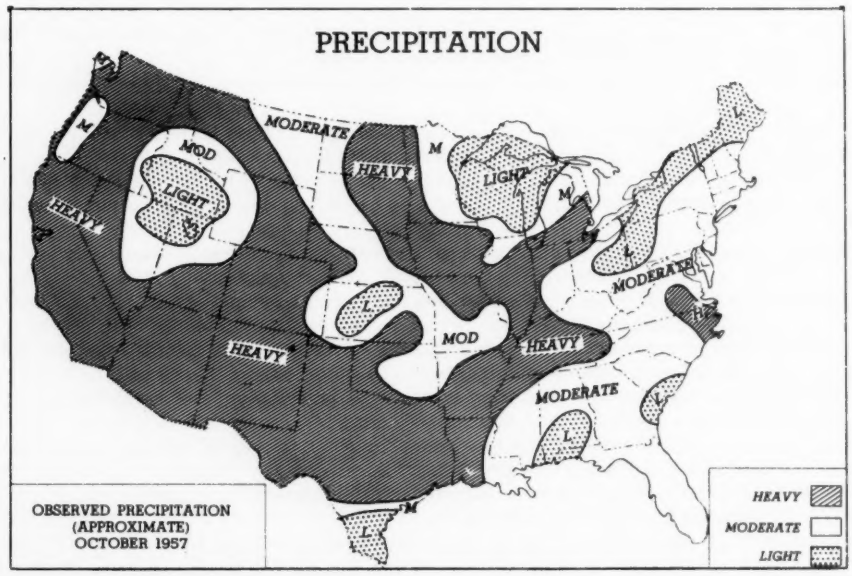
CLARK T. ROGERSON records two new hosts for Verticillium albo-atrum, and several additions to the host list for Kansas, page 1053.

Records of citrus canker and sweetpotato scab in Micronesia are listed by ANNA E. JENKINS and F. RAYMOND FOSBERG, page 1055.

Unusual Records, page 1057: Sclerotinia on strawberry fruit in Washington, D. M. McLEAN. Nut disease in Oregon in 1957, P. W. MILLER. Root-lesion nematode from redcedar in Nebraska, FIELDS E. CAVENESS. Leaf mold on field tomatoes in Connecticut, SAUL RICH. Field infection of radish roots with Peronospora parasitica, SAUL RICH.

Corrections: page 1059. October Weather, page 1060. Manuscripts for the Reporter, page 1061.





The terms used in the accompanying maps, which define the ranges of temperature and precipitation, are numerical class limits. These are based on a statistical analysis of past records through which is determined the normal frequency of occurrence of temperatures and precipitation at various times of the year for different locations. For temperature the classes above, below, and near normal are so defined that they each normally occur one-fourth of the time; much above and much below normal, one-eighth of the time. Precipitation is depicted in terms of light, moderate, and heavy, each class normally occurring one-third of the time and thereby having equal probability of occurrence. These maps graphically represent only the general trends and give the country's weather picture at a glance. For quantitative studies, where monthly mean temperatures and actual precipitation records are needed for a given time and place, other publications of the Weather Bureau should be consulted. P. R. M.

MANUSCRIPTS FOR THE PLANT DISEASE REPORTER

(See also PDR 35: 121-122; 36: 214, 494)

(1) GENERAL. The Reporter page measures 9 inches long with the heading or 8 3/4 inches for the text part, by 6 inches wide. The copy is typed on a larger page, 11 1/4 inches of text or 12 inches overall in length by 8 inches in width, and reduced 25 percent in the photographic process of reproduction. Illustrations or tables larger in either dimension will take a correspondingly greater reduction. Only one size of type is available for text, footnotes, or tables.

(2) MANUSCRIPTS should be the original ribbon copy, not carbons, clearly typed and double-spaced throughout, including tables, footnotes, and bibliographies. (Note -- only one copy is needed.) Footnotes should be typed at the bottom of the page.

(3) ABSTRACTS are requested for all except very short articles. (PDR 38: 316).

(4) CAUSES OF DISEASES should be named. For bacteria, fungi, nematodes, etc., give the Latin name of the organism; for viruses either or both the accepted common name of the virus or a Latin name if you prefer it and there is one; for non-parasitic diseases state the causal factor if it is known. If the cause of a disease has not been determined say so. (PDR 36: 494).

(5) LITERATURE REFERENCES should be given in alphabetical order and numbered for citation in the text. We follow the AIBS suggestion of placing the year of publication after the author's name. Please check your titles carefully since we cannot do it for you. Be sure that text citations and bibliography agree; that foreign-language references are correct; that number or month is cited for periodicals that are not paged consecutively throughout the volume.

(6) NAMES OF FUNGICIDES should be given according to the suggestions that will be published in Phytopathology before long, and later repeated in the Reporter. In the meantime see PDR 35: 122.

(7) ILLUSTRATIONS should be sent to us unmounted. To prevent mistakes, write figure numbers on the back, and mark the top of each print when necessary. A sketch can show a preferred arrangement but please keep in mind page size, shape, and standard reduction (see above under General), and remember that figure titles and legends are part of the page. Lettering should be clear and large enough to be legible after reducing. Drawings, maps, and graphs can be photographs or originals, but should be finished and ready for reproduction, not just sketches.

(8) TABLES should be carefully thought out with particular attention to the Reporter's limitations in reproduction. Make titles and headings definite and self-explanatory. Designate footnotes in tables with superscript lower-case letters. Be sure that text discussion agrees with the data in the table. Do not abbreviate names of crop varieties.

(9) REPRINTS cannot be supplied since there is no way in which we can be reimbursed. However,

(10) The MULTILITH PLATES from which reprints can be made will be sent if requested at the time the article is submitted. The press size of these plates used for the Reporter is designated as small -- maximum image 9 1/2 by 13 inches, maximum paper size 9 3/4 by 14 inches -- for Model 1250. Most of the Experiment Stations have this type of multilith machine.

(11) We are the official correspondents in the United States of the PLANT PROTECTION BULLETIN published monthly by the United Nations Food and Agriculture Organization. We would appreciate it if plant pathologists would send us suitable material from time to time for inclusion in our monthly summary reports. Please mark it clearly so that we will know it is intended for the Bulletin. (See PDR 36: 492; 37: 637) -- P. R. M.

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